The Foundry Trade Journal

AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 13. **MAY, 1911.** **No. 113.**

PUBLISHED THE FIRST WEEK IN EACH MONTH.

Subscription Terms: 7s. 6d. per annum, post free.

To place the "JOURNAL" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop at the reduced rate of **5s.** per annum, such order to be countersigned by the superintendent or foreman.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

WE INVITE PRACTICAL ARTICLES ON THE TRADE IN ALL ITS BRANCHES, WHICH WILL BE PAID FOR. MSS. SHOULD BE WRITTEN ON ONE SIDE OF THE PAPER ONLY.

BRITISH FOUNDRYMEN'S ASSOCIATION.

LIST OF SECRETARIES—

General Secretary: J. E. H. Allbut, "Meadow Lea," Highfield Road, Stretford, Manchester.

Manchester: H. Sherburn, Rotherwood. Stockton Heath, Warrington.

Birmingham: George Hailstone, 97, Katherine Street, Warley, near Birmingham.

Cardiff: H. Griffiths, Messrs. J. Williams & Sons, Ltd., Globe Foundry, Cardiff.

Sheffield and District: R. W. Kemlo, 6, Lees Hall Road, Meersbrook, Sheffield.

Glasgow: J. A. Ewen, 124, Pollok Street, S.S., Glasgow.

London: T. Murphy, 21a, Brooksby Street, London, N.

Contents.

	PAGE
Notes and Comments	247
American Foundrymen's Convention	248
Annealing Malleable Castings	249
Technological Instruction in Moulding	250
Corrosion of Metallic Food Containers	254
Alloys of Brass and Bronze	255
President of the London Branch of the B.F.A.	257
Hardness Tests on Alloys	258
The "Frick" Electric Furnace	259
Notes on Foundry Efficiency	260
Manganese Steel	261
Some Alloys of Alluminium	262
Stiffening Cores in Sand Moulds	266
A Quick Method of Moulding Small Flange or Groove Pulleys	268
Imperfect Castings	269
Business Methods for the Ironfounder	271
Points in Favour of Machine-Made Cores	273
Foundry Practice	274
Hoists for Foundries	276
Modern Foundry Practice; Its Opportunities and Demands	277
Presentation to Mr. T. Swinden	279
The Value of Science to the Foundryman	280
Case-Hardening	283
Foundry Plant and Equipment	285
Inventions	287
Trade Talk	289
New Companies	290
Deaths	292
Personal	292
Legal	292
Prices of Metals	294

Forthcoming Events.

MAY 6.

British Foundrymen's Association (Birmingham Branch).—Annual meeting.

MAY 11 & 12.

Iron and Steel Institute.—Annual London meeting, at Institution of Civil Engineers, Great George Street, Westminster.

MAY 13.

British Foundrymen's Association (Scottish Branch).—"The Melting and Casting of Iron," by R. Buchanan, F.R.S.A.

MAY 27.

British Foundrymen's Association (Birmingham Branch).—"The Mechanism of the Production of Malleable Castings," by D. M. Levy, M.Sc., A.R.S.M.

NOTES AND COMMENTS.

The Testing of Alloys.

On another page we publish some interesting results of hardness tests on alloys made with the object of determining by a simple means, if possible, the approximate composition of alloys, and their suitability for certain purposes. The object in view was a commendable one, for, were it possible to establish, as many have attempted to do, a defined relationship between the chemical and physical properties of alloys, the testing of such for works purposes would be greatly simplified. It is matter for no great surprise, however, that the hardness test as recorded by the scleroscope, should have failed to give any useful information on the matter, for of all the tests applied to metals, the hardness test is the most uncertain and difficult to record in a satisfactory manner. The very term, "hardness," itself, conveys to different minds different ideas of properties. To one the term signifies resistance to penetration, to another the resistance to abrasion, while in other cases the resilience or elasticity of the metal is not taken into account, but the hardness is measured by the rebound of an object falling on to the surface of the metal. The tenacity of an alloy may also affect the apparent hardness, and this, again, complicates the question. However, any of the recognised methods of hardness testing may be made to give comparative results when used for the same class of metal or alloy, though the scleroscope, for example, will not give results for two distinct classes of material that will be at all comparable. But to return to the experiments now under consideration, the Shore scleroscope was used, the materials tested being (1) copper-alumin um-zinc alloys, (2) gunmetals, (3) phosphor-bronzes, and (4) cast-iron. In the first class alloys with variation in composition which would materially affect tensile stress results gave the same hardness number, indicating that hardness is not greatly susceptible to small variations in composition in this class of alloys. Gunmetals, too, did not show appreciable variations in hardness, despite wide variations in composition, while as regards phosphor-bronze, the results quoted are not sufficient to base any conclusion on, though it is fairly obvious that the hardness is dependent on the amount of phosphorus and tin, but, as to the respective effects of these two, further experiments would be necessary before any definite conclusion could be arrived at. Cast iron presented what appeared to be anomalous results, for the relation between the presence of what are generally recognised as hardening elements and the test results was not the same in each case. But it is quite possible that one or more of several important factors were overlooked, as, for example, the rate of cooling affecting the size of the crystals; for though the combined carbon in two irons may be the same, a variation in the rate of cooling will affect the crystallisation, and hence the hardness results. It would be interesting to know, also, how the specimens were prepared for testing,

or whether the results represent tests made on the surface as cast. Regarding the non-ferrous alloys, it is difficult to suggest what would be the best method of testing hardness, but the Shore scleroscope, at any rate, does not appear a suitable instrument, recording, as it does, hardness plus elasticity. Whether the drill test would be better is, perhaps, doubtful, as the results would be affected by the tenacity of the material, as well as the actual or mineral hardness. Turner's sclerometer test, which involves the production of a standard scratch, suggests itself as the best method of arriving at the actual hardness of the material, but it is doubtful whether the hardness of an alloy will ever be made to serve as a useful index to its other properties and its composition.

Shrinkage Tests for Iron.

While hardness tests alone may not be made to serve as a reliable index to composition, there are important possibilities before the founder who will take the trouble to systematise the testing of his iron. Take, for example, the shrinkage test as recorded by Keep's or any other approved method. The results of this test, if systematically recorded over a number of representative melts with a certain mixture, can be made to indicate at once when favourable melting conditions are not being maintained, or, on the other hand, whether the iron being used is below the standard. This applies particularly to the silicon content of the iron, for shrinkage, as effectually demonstrated by Keep, bears a close relation to the silicon content, the greatest shrinkage accompanying the least silicon, and *vice versa*. It is obvious, therefore, that a variation in the shrinkage results obtained from day to day with nominally the same mixture of iron and on the same size of test bar, will indicate a variation in the silicon content of the charge, provided the melting conditions have not been changed. The relation between shrinkage and silicon is fairly well understood, that element having the effect of changing combined carbon into graphitic, and hence not only reducing the shrinkage, but also the hardness. To a foundry producing castings that have to be subjected to machining processes, then, the shrinkage test should be very useful as indicating at least that change in composition which is likely to cause hardness, and hence trouble in machining. Should, however, the standard of the cupola charge not have been altered, any material variation in the shrinkage test results would point to some irregularity in the melting procedure—probably an oxidising influence having been introduced. An example of this was mentioned last month by Mr. T. H. Hawley before the Lancashire Branch of the British Foundrymen's Association. Systematic records of shrinkage had been kept, the normal figure ranging between 129 and 132 for easy machining (silicon content 3.0 to 3.5 per cent.); but one pair of test bars showed shrinkages of 145 and 150, clearly indicating some important change in the condition of the castings. As the charge mixture had not been altered, attention was directed to the cupola, and it was discovered that the change was the result of over-blowing causing undue oxidation of the silicon and carbon, and hence depleting the iron of the elements which decrease shrinkage. It must, of course, be remembered that the influence and not the percentage of silicon is the governing factor in its effect on the physical quality of the iron, the influence varying according to the other elements present. But, as previously suggested, where the composition is approximately constant, as in the case of many standard mixtures in use for long periods at a stretch, the shrinkage test can be applied as a handy check on changes in melting conditions and composition. Stress tests are also largely applied for checking daily practice, and are very necessary where strength requirements have to be met, but the factors influencing stress test results are so numerous that the question assumes a very complex character, and only in the case of a few specialities has anything like a system been evolved—that is, a system which can be made a continual check on the melting conditions, composition of the iron, and other variables.

American Foundrymen's Convention.

The provisional programme of the joint Convention of the American Foundrymen's Association and the American Brass Founders' Association, to be held at the Exhibition Building, Duquesne Way, Pittsburg, May 22 to 26, has been issued. The following is the general arrangement of sessions with a tentative indication of the papers that will be discussed:

TUESDAY, MAY 23.—Joint Session.—Addresses of welcome. Papers on "Production Cost," "Economic Foundry Insurance," "Uniform Contracts."

Separate Sessions.—A.F.A.: Papers on "Unloading Methods," "Use of Borings in Cupolas," "Effect of Alloys in Cast Iron," "Permanent Moulds." A.B.F.A.: Papers on "Vanadium in Non-ferrous Alloys," "Determination of Nickel in Bronzes," "Pouring High-Grade Bronzes."

Foundry and Machine Exhibition Company, Exhibit. Open throughout the week during the day, and Saturday evening, May 27.

WEDNESDAY, MAY 24.—Joint Session.—Papers on "Rotary Blowers," "Foundry Construction," "Heating and Lighting Systems," "Patternmaking," "Moulding Machines."

A.F.A Session.—Papers on "Acid and Basic Open-Hearth Processes," "Electric and Converter Furnaces for Steel Castings," "Effect of Vanadium and Titanium on Steel." A.B.F.A. Session.—Papers on "Corrosion of Brass Foundry Products," "Pyrometer and the Aluminium Foundry." "Non-ferrous Foundry Economies," "Equilibrium Diagrams."

Visits to Works.

Dinner.—Pittsburg and Associated Foundry Foremen.

THURSDAY, MAY 25.—Joint Session.—Papers on "Moulding Sand," "Use of Alloys," "Shot in Castings."

Train excursion to foundries and steel works (Pennsylvania-Union Station).

Entertainment by Foundry and Machine Exhibition Company.

FRIDAY, May 26.—Separate Sessions.—Election of officers and reading of papers.

Pittsburg and Cincinnati ball game at the Forbes Field.

Subscription dinner.

THE Governing Body of the Imperial College of Science and Technology, in their third annual report, give very full particulars of the various building schemes which are in progress. The new laboratory for the mining and metallurgy department is nearly ready for use, and the contract for a second portion of the building devoted to this department will be let at an early date. The students' new accommodation is also well in hand, and is expected to be ready for occupation in the coming session. The Bessemer Memorial Committee have made a donation of £10,000 towards the mining and metallurgical laboratories.

Annealing Malleable Castings.*

By W. P. Putnam.

To call attention to the variations that can be produced in the annealing process, in manufacturing malleable castings, a set of test bars was made and sent out to 11 malleable iron foundries to be annealed in accordance with their usual practice. The bars were all made from the same metal and an attempt was made to obtain a bar free from shrinkage or draw in the centre by casting the bars with large ends. In all of the bars that were broken but very little draw was found. The analysis of the metal poured into the bars was as follows:—Silicon, 0.74 per cent.; sulphur, 0.041 per cent.; phosphorus, 0.148 per cent.; Manganese, 0.24 per cent.; combined carbon, 2.70 per cent.

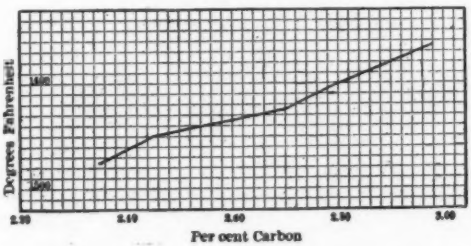


FIG. 1.—PROPER FINISHING TEMPERATURE FOR THE ANNEALING OF WHITE IRON, IN RELATION TO CARBON CONTENTS.

The results obtained on the annealed bars are given in the accompanying table. It will be noticed that in each case under too high temperature or a long period of annealing, the carbon was nearly all removed. Either practice is wasteful and produces poor malleables for some purposes. The annealing process should be conducted to produce definite results. Metal intended for parts where machining is necessary should be given a different treatment in the annealing process from that of metal that does not need to be machined.

To arrive at the proper annealing temperature the critical and proper annealing temperature was ascertained on a number of hard iron specimens ranging from 2.35 to 3 per cent. total carbon. These temperatures are diagrammatically shown in Fig. 1. They are accurate within 10 deg. Fah.

Diagram Fig. 2 shows the curve of a typical annealing cycle in an oven containing 14 tons of castings. The carbon in this lot of iron was 2.65 per cent. After reaching the annealing temperature there is no further rise in the temperature of the metal until all of the carbon has changed into the graphitic condition. As soon as the change has been completed the temperature will rise in accordance with the temperature of the oven. It has been found that to heat the castings much above the proper annealing temperature for a long period is not only unnecessary, but a waste of fuel, and produces poor castings for some purposes. After the carbon has all been changed the oven need not be fired for more than six hours. When the metal has gradually cooled to 1,200 deg. Fah., the cooling can be hastened as rapidly as desired without harming the quality of the castings.

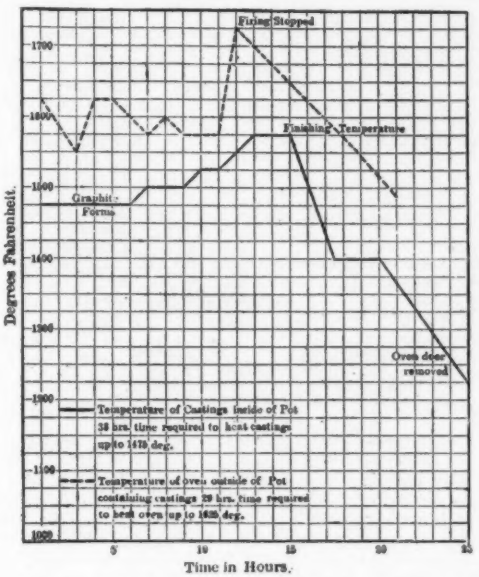


FIG 2.—CURVE OF A TYPICAL ANNEALING CYCLE.

TABLE 1.—*Results of Annealing Bars of the same Composition at different Foundries.*

Foundry No.	Total carbon.	Graph. carbon.	Comb. carbon.	Elastic limit. Lbs. per sq. in.	Tensile strength. Lbs. per sq. in.	Elongation in 2 in. Per cent.	Reduction in area. Per cent.	Packing used.	Time of annealing. Hours.	Annealing temperature. Deg. F.
1	1.49	1.49	Trace	20,823	40,996	8.59	12.13	Slag	112	1,450
2	1.94	1.91	Trace	34,134	44,034	10.15	13.87	Mill scale	144	1,700
3	1.47	1.47	Trace	29 276	39,638	8.59	17.63	Mill scale	101	1,620
4	0.86	0.77	0.09	31,428	48,489	8.59	19.18	Not given	Not given	Not given
5	1.74	1 74	Trace	30,960	45,760	8.59	14.88	Not given	Not given	Not given
6	1.71	1 71	Trace	28,326	40,408	8.59	15.00	None	72	1,650
7	1.32	1.18	0.14	32,224	49,107	8.59	13.23	Not given	Not given	Not given
8	0.80	0.80	Trace	33 333	47,336	7.60	17.27	Slag	208	1,620
9	1.58	1.58	Trace	30,833	39 862	7.03	19 51	Mill scale	168	Not given
10	0.40	0.40	Trace	41,792	50,819	7.45	20.92	Mill scale	96	2,200
11	1.32	1.32	Trace	35,042	45,213	7.80	12.56	Slag	144	1,700
Hard Iron ...	—	—	2.70	—	50,846	—	—	—	—	—

Some of the reasons why hard and brittle castings are occasionally found may be given as follows; (1) Under annealing (which may be caused by too low temperature or by holding the castings at the proper temperature for too short a period). (2) Too rapid cooling of the castings after being annealed. (3) Heating annealed castings above the critical temperature to straighten without subsequent annealing. That there is great need of the systematic handling of the annealing process is clearly evident from the results tabulated. The variations there shown are typical of castings in general.

* Abstract of Paper read before the Detroit Foundrymen's Association.

Technological Instruction in Moulding.

In the course of time the meaning of the expression "mechanical technology" has undergone several changes, and is even now differently understood by different people. Originally it implied the entire study of the treatment of raw materials in converting them into articles of use by mechanical processes. Conceived thus generally, this science occupies an immense field, which far exceeds the capacity of any

FIG. 1.—SHAPING SAND PATTERN FOR TOP BOX.

single teacher; and could, in fact, only be taught in an encyclopædic fashion, which, however, would merely result in superficiality, overloading the memory without imparting lasting benefit to the student to carry with him into practical life. It is much preferable to enable the student to gain a deeper insight into a more restricted field of study, to widen his faculty of comprehension

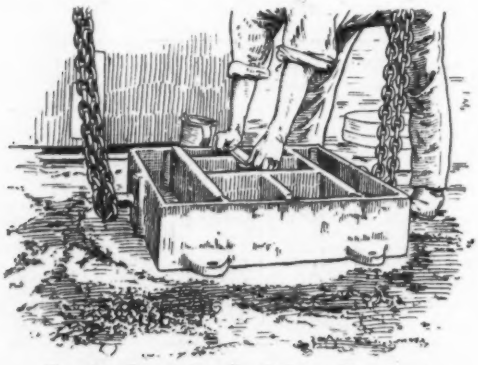


FIG. 2.—PLACING AND FITTING TOP BOX.

and school him to distinguish between essentials and non-essentials, and accustom him to seek out and utilise the general laws in the various branches of technical activity. In order to produce this result it is necessary to go thoroughly into the subject chosen and avoid superficial pottering, since otherwise the student will tend rather to acquire an over-estimate of his own capacity rather than a proper technical education.

Bearing these principles in mind, the work in the mechanical engineering department of the Charlottenburg Technical High School has been restricted, in the branch of mechanical technology, to the study of manufacturing metallic raw materials into the principal objects of interest for the machinery constructor, the study of the metallic raw materials being also included, of course. Another point that had to

FIG. 3.—DRIVING GUIDE-RODS FOR TOP BOX.

be borne in mind was that the teaching was to serve as a preliminary stage to instruction in structural work, and therefore had to be included in the first two years of the course, the leading idea being that such instruction was impracticable unless the students had already reached such a stage as to enable them to grasp the requisite points in connection with the choice of material, the possibility of shaping it to the desired form, and any defects exhibited, either in the material itself or in its preliminary treatment.

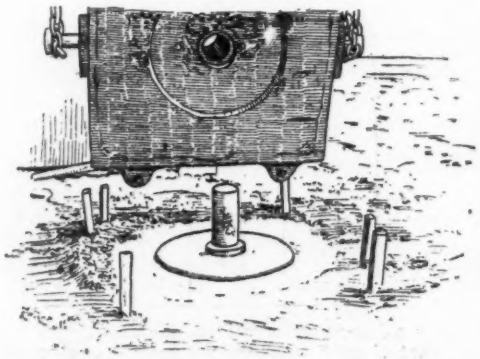


FIG. 4.—LIFTING RAMMED TOP BOX.

In order that such instruction may be profitable it is not sufficient for the student to be able to adapt a structural part to its destined purpose merely on paper, but it must also lay stress on the question how the said part can be produced economically and with the requisite security from the raw material selected.

In the first year of the course, the technological

* Professor E. Heyn; abstract translated from Zeitschrift des Vereines Deutscher Ingenieure.

instruction given includes a lecture, of two hours' duration, on the study of iron, together with sufficient instruction in the metallurgical treatment of the metal

FIG. 5.—DIGGING OUT FLOOR.

to facilitate comprehension of the material and particulars of the casting process. In the second year of the course, a four-hours' lecture is devoted to the shap-

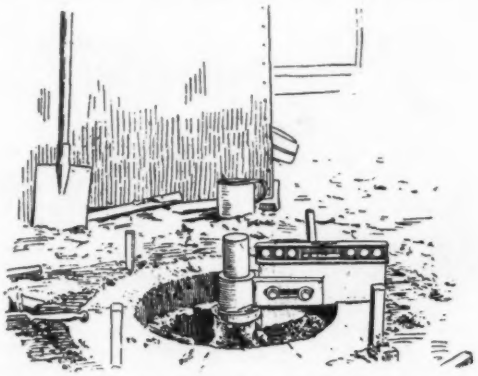


FIG. 6.—SETTING UP TEMPLET.

ing of the material by forging, rolling, drawing, pressing, etc., and with the aid of cutting tools. Then follows the actual study of the materials, to teach the

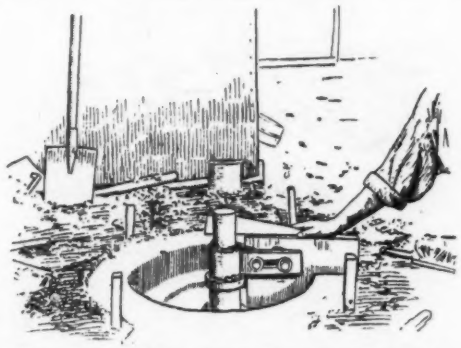


FIG. 7.—SHAPING LOWER PORTION OF MOULD WITH TEMPLET BY HAND.

characteristic properties of the metallic raw materials and the alterations they sustain by variations in treatment in the course of shaping, or during service in machinery or structural work. It being recognised that mere lectures are not sufficient to enable the

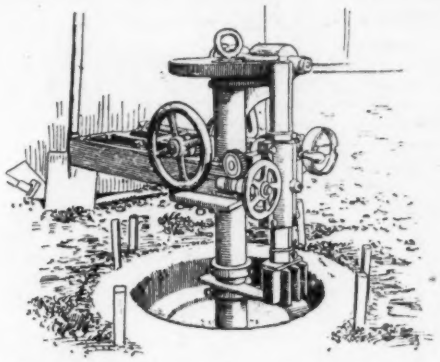


FIG. 8. — MOUNTING PINION MOULDING MACHINE ON SPINDLE. ADJUSTING TEETH-SHAPER TO RADIUS OF HEAD CIRCLE.

student to penetrate deeply into the subject, and that a certain degree of independence should be acquired, practical instruction is given twice a week in

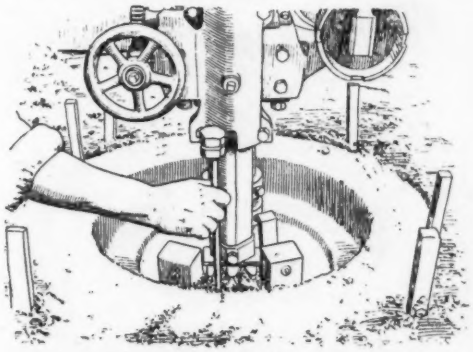


FIG. 9.—RAMMING THE FIRST TEETH GAPS.

the second year, the students performing selected tasks in the various branches of technology under the supervision of a practical expert and his assistants.

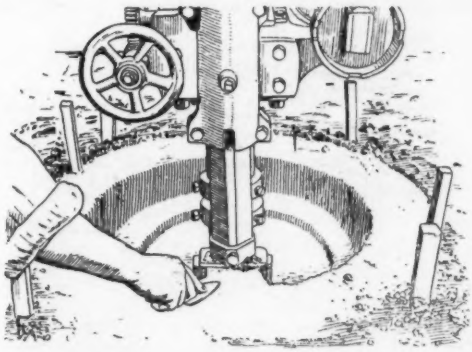


FIG. 10.—SLEEKING THE SAND IN THE RAMMED GAPS.

To prevent misunderstanding, it should be expressly mentioned that the selection and performance of

these tasks is not intended to replace technical education in the foundry and workshop, as in the preliminary practical course. They are only meant to supplement in a systematic manner the practical preparation of the students.

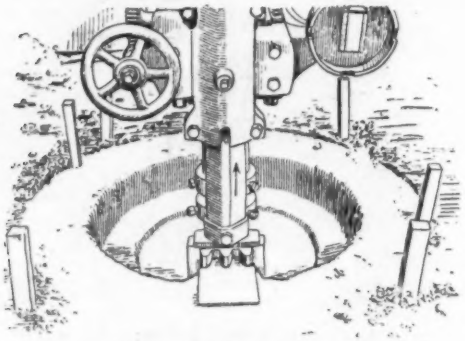


FIG. 11.—LIFTING SHAPER IN DIRECTION OF ARROW.

To illustrate the manner in which the solution of these tasks is effected, may be taken the example of the casting of a pinion in grey iron. In the first

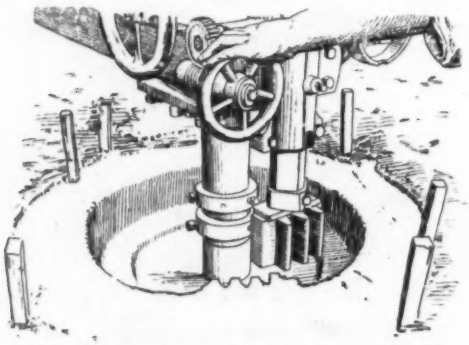


FIG. 12.—SHIFTING SHAPER A DISTANCE OF TWO TEETH AND THEN RE-LOWERING IT.

place the selection of the material (cast iron, cast steel) is discussed, and also the various methods of production (moulding by hand from a pattern, and

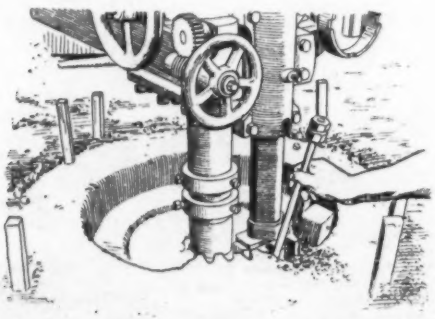


FIG. 13.—RAMMING FURTHER TEETH-GAPS.

different types of moulding machines; casting the blank wheel and then cutting the teeth, etc.). After an explanation of the suitability of one or the other method for special cases, it is decided, for instance, to use templets and the pinion-moulding machine. The several stages of the process are illustrated by photographs (of which over 1,350 have been prepared by the students themselves, for the most part through

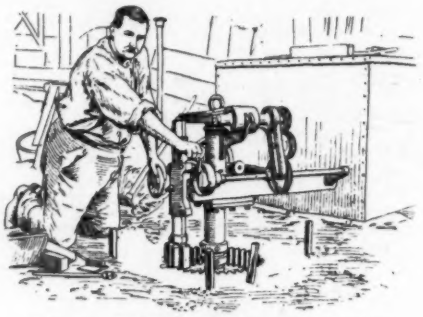


FIG 14.—RAMMING FINAL TEETH GAPS.

the facilities kindly afforded by manufacturers to photograph actual working operations), as sketched in Figs. 1 to 23. In these illustrations, Figs. 1—4 show the preparation of the top box; Figs. 5—16 the pre-

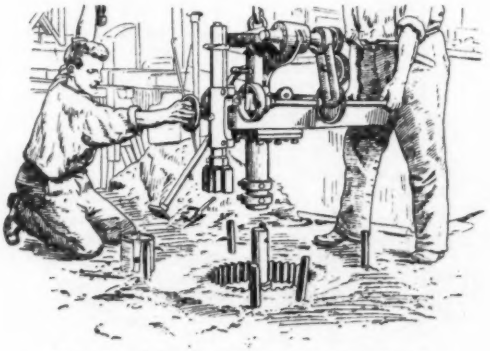


FIG. 15.—LIFTING SHAPER FROM SPINDLE.

paration of the lower box in the floor; Figs. 17—20, the making of the core; Figs. 21 and 22 the finishing of the mould; Fig. 23, boring out the hub.

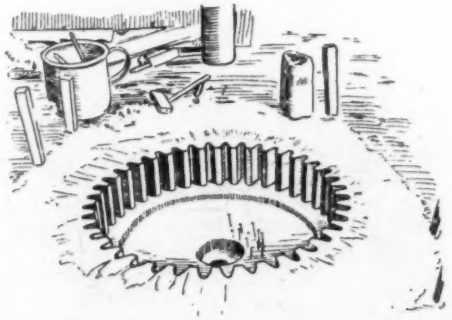


FIG. 16.—LIFTING SPINDLE; PEGGING MOULD.

The students then have to draw sketches of the course of moulding, more stress being laid on whether the student has thoroughly understood

the matter than on perfect drawings. The sketches must be made so that they are self-explanatory without any descriptive text

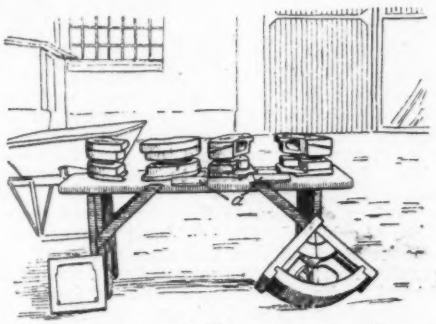


FIG. 17.—CORE-BOX AND CORES FOR X SECTION ARMS INSTEAD OF | SECTION ARMS; *a* = SPLITTING CORE FOR SPLITTING THE WHEEL.

Another example is the forging of a triple-crank shaft. After discussing the selection of the material

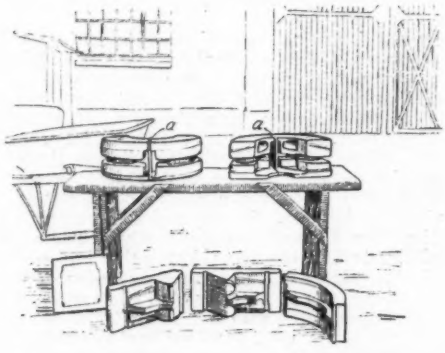


FIG. 18.—CORE-BOX OPEN; CORES PARTIALLY ASSEMBLED; *a* = SPLITTING CORES.

(open-hearth steel, crucible steel, nickel steel) and the examination of same, the various stages of manufac-

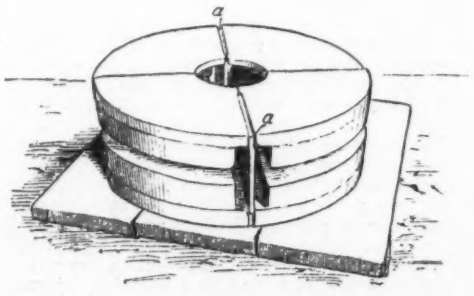


FIG. 19.—ARM CORE AND SPLITTING CORE *a* ASSEMBLED.

ture are briefly illustrated by means of pictures and models.

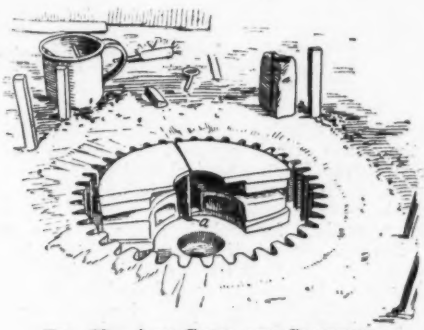


FIG. 20.—ARM CORE AND SPLITTING *a* LOWERED INTO MOULD.

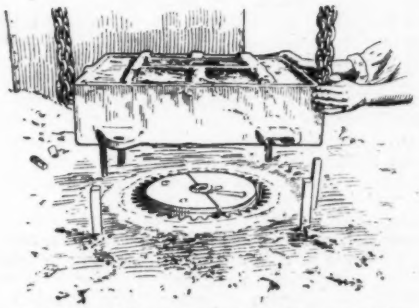


FIG. 21.—HUB CORE IN POSITION AND TOP BOX BEING LOWERED.

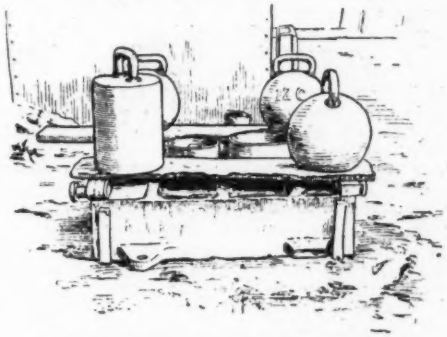


FIG. 22.—MOULD READY FOR POURING.

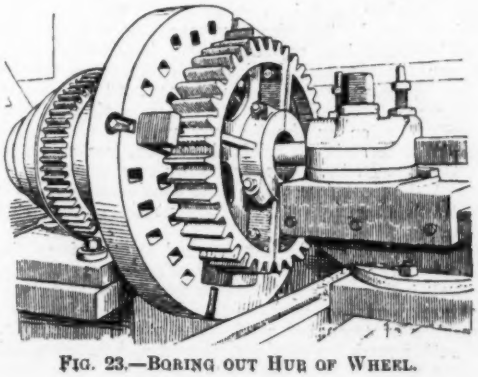


FIG. 23.—BORING OUT HUB OF WHEEL.

Corrosion of Metallic Food Containers.

In the course of a Paper read at a recent meeting of the American Electrochemical Society, Mr. Edward Gudeman, Ph.D., presented the following interesting information:—

With a product for analysis one will be satisfied to call it a c.p. product, if the amount of total impurities is 0.001 per cent. or less. Atomic weights generally do not go beyond the second decimal place, and most chemists in figuring analytical results use only the first decimal figure. In food chemistry, however, a quantity of 0.001 per cent. is often considered a tremendous quantity.

Tin, copper, lead, silver, and iron are very soluble metals (especially when traces are taken into consideration) in the liquids used with canned food products and in the peculiar liquids produced in the decomposition of foods. It is immaterial how the food itself is protected; it will undergo some decomposition, not necessarily putrefaction nor producing an unwholesome product. This decomposition is often a very slow one, not noticeable until months or years have passed since the product was put into the hermetically-sealed container.

Among the two most commonly found products of decomposition are sulphuretted hydrogen and carbonic acid. Carbonic acid is one of the strongest corroding acids known, especially when acting under pressure on metals in the presence of water. Carbonated beverages are always under carbonic acid pressure varying from 5 lbs. to 125 lbs. per square inch, and the decomposition of food products giving rise to carbonic acid produces a pressure, and thereby solvent action is increased. This no doubt explains why food products placed in vacuum containers are less liable to deterioration.

Tin is a good protecting medium for iron under two conditions: The coating must be perfect and the contact between the tin and the iron must be perfect. The author has never seen a piece of tinplate where both of these conditions were met with, and very few where either of these two conditions was fulfilled.

There are four main reactions that take place with food products, due to the character of the foods themselves or to their decomposition under normal conditions of ageing. There is either oxidation or reduction, or both, and the action of acids or alkalis, or both. A perfect container will be one that will withstand all of these reactions.

One cannot tell with certainty which reactions will take place nor how they will take place nor when. Iron is porous, and in tinplating the pores are not filled or coated. Tin also is porous, and this porosity must be taken into consideration. A perfect contact between the tin and the iron is of the greatest importance, using sufficient tin to coat all the superficial area of the iron. With such a tinplate the corroding action on the tin only need be considered. After a large series of trials this object was attained, but the process is not commercially successful, as the cost of the container is a vital consideration, being about twice the value of the present tin can with its contents.

Iron and steel can be impregnated so as to have the resisting properties of gold. Steel springs, knives, surgical instruments, etc., look like gold and have the insolubility of gold, with all the characteristic properties of tempered steel. The process is simple. The author made an amalgam of gold and impregnated the iron article with such liquid amalgam, then by heat vaporised the mercury and obtained an iron-gold article that withstood the corroding action of acids, exactly like gold. The amount of gold required was very small, about 2 ozs. of gold to a ton of iron being sufficient, figuring this from the small experimental samples made.

The serious objection to this process was that the amalgam of gold had to be liquid and it was necessary to vaporise about 99½ lbs. mercury for every ½ lb. of gold used, an amalgam of over ½ per cent. not working satisfactorily. Experimentally the process is a success, but commercially the cost of operation is such that the cost of such a plate will be from 12 to 15 times the cost of a tinplate, making the cost of the gold-iron container exceed, often, the cost of the present container with contents.

Other liquid alloys were tried and some very peculiar results obtained. Copper impregnated with sodium amalgam was found to resist the action of acids and water to a greater extent than the metals themselves. The author has no explanation to offer why a copper-sodium plate should resist acid more than the copper itself.

Very peculiar results were obtained when impregnating copper with antimony amalgam. It was found that such antimony-impregnated copper greatly resisted the action of dilute nitric acid, the amount of copper that went into solution from the surface contact being not over 10 per cent. of the amount that went into solution from the edges. The acid penetrated from the edges toward the centre, and the rapidity of the solvent action of the acid from the edges toward the centre was visibly noticeable. Strength of acid, temperature and time are factors that materially influence this action. Protecting the edges by dipping into paraffin showed conclusively that the corroding action of nitric acid on copper was greater than on the same amount of copper impregnated with antimony.

Very extensively used for food containers are the so-called enamelled cans. They are not real enamelled cans, but simply metal plates on which an enamel has been baked. Real enamel should become part of the whole and not simply a superficial protecting coating that can be separated by mechanical means. Experiments were made to impregnate enamels in iron plates, but the high pressure required makes the process too expensive to be commercially developed now. The enamel was forced into the iron plate at a pressure of about 50,000 lbs. per square inch. The superficial excess coating of enamel was scraped off the plate and the impregnated plate was subjected to a heat sufficient to melt the enamel. Enamel-impregnated iron plates withstood the action of acids and alkali fully as well as glass.

There were many difficulties found in using enamels, and experiments were then made to impregnate iron plates with glass. The results were most satisfactory, and until the process and products are fully protected no details can be given. The best results were so far obtained when using a very fusible lead-glass. The amount of lead that will go into solution has not yet been determined. Whether such a container will meet the requirements of food officials and food chemists, who condemn food products containing 0.00003 per cent. of lead and who consider about 0.000001 per cent. of sulphur dioxide as unwholesome, remains to be seen.

Alloys of Brass and Bronze.

Lecture before London Branch of British Foundrymen's Association.

On Friday, April 7, at Cannon Street Hotel, the first lecture given before the recently formed London and District Branch of the British Foundrymen's Association was delivered by Mr. Percy Longmuir, B.Met., President of the parent Association. Mr. J. Oswald, Branch President, occupied the chair, and was supported by Mr. J. W. Horne (Branch Vice-President), Mr. E. A. Chell, Mr. R. Woods, Mr. T. C. Aston, Mr. S. Waterhouse, and Mr. T. Murphy, Branch Secretary. There was an excellent gathering of members and visitors, numbering in all about 100.

The lecturer, in his opening remarks, stated that at the inaugural meeting of the Branch it was suggested that, in view of the importance of the brass foundry industry in London, the first lecture should be one of interest to brass founders. In a first lecture it was advisable to keep down as far as possible to the level of current practice, and therefore he would confine his remarks to an examination of the field covered by the term "brasses and bronzes." The antiquity of this industry was familiar, and notwithstanding the enormous advance made by steel, the volume of business in brass or bronze was very considerable, and also very varied, as a comparison of brass foundry practice in a marine centre such as the Clydeside with the type of work done in the Birmingham district would show. But notwithstanding the variety of products, the underlying principles were common throughout. A general examination of these principles would show that though the types of alloys vary, two particular ones stand out prominently as to a certain extent representing the whole; these two were standard yellow metal (70: 30) and standard gun-metal (88: 10: 2).

Production of Alloys.

On the subject of the production of alloys, the speaker proceeded to explain that an alloy was an intimate mixture or union of metallic substances which on melting would not separate into two distinct liquid layers. Alloys might be produced by compression of the constituent metals, by diffusion, or by cementation, an example of the latter being the case-hardening process for introducing carbon into iron. Commercial alloys were produced by fusion in gas-, coke- or oil-fired crucible furnaces, and in gas- or coal-fired reverberatory furnaces, the coke-fired crucible furnace being the usual one for small quantities and the coal-fired reverberatory furnace for large quantities.

He proceeded to emphasise the fact that success in the production of alloys could only be attained by practical experience and contact with the difficulties encountered. There was no royal road to success, and no text-book without practical experience was of material assistance.

Oxidation.

The question of oxidation in the production of alloys was a matter of vital interest, and was associated with many of the difficulties encountered in the foundry. Instancing one of the effects of the oxidation of copper, it was explained that while pure copper solidified at 1,084 degrees C., when it contained 3.5 per cent. of cuprous oxide the freezing point fell to 1,065 degrees C. Further oxygen, curiously, raised the freezing point, the changes giving a curve, if plotted as a diagram, something like the following:—

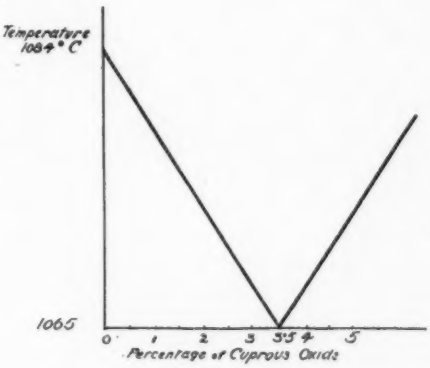


DIAGRAM SHOWING EFFECT OF CUPROUS OXIDE ON FREEZING-POINT OF COPPER.

These features had a direct practical bearing on the resulting properties of the alloys, whenever oxygen was asorbed by the metal in the molten state, as the oxide, if retained in the cold metal, affected its malleability.

Dealing with deoxidisers, the lecturer exposed the fallacy of assuming that charcoal, when placed on the top of a pot of metal, acted as an effective deoxidiser. Charcoal would be effective when handling small quantities, but in a crucible of, say, over 30 lbs., it was not so, since the charcoal did not come into contact with more than the top metal. If held at the bottom of the crucible, however, the charcoal would effectively deoxidise the metal. Other deoxidising agents were zinc, phosphorus, silicon and manganese, which, when introduced, permeated the mass of metal and combined with the oxygen to form oxides which rose to the surface. German silver was deoxidised by manganese, and could not be produced satisfactorily without that metal, as the nickel used in manufacturing the alloy almost invariably contained some oxygen.

Brass alloys were not so subject to the troubles of oxidation, as the zinc used in the composition acted as a deoxidiser to the copper. With the bronzes, or copper-tin alloys, however, the case was entirely different, as tin, like copper, united with oxygen to form an oxide which was retained by the metal and not sent to the surface. Metallic tin would reduce copper oxide, but the oxygen was not eliminated, it being retained in the alloy as a tin-oxide. As, however, the Cu-Sn. alloys had little industrial application the matter was not a really serious one, but with the triple alloys of copper, tin, and zinc, the case was different. These were largely used, and the oxidation of the zinc was important; the losses of zinc due to combinations with oxygen and to the metal's volatile character at the alloying temperature, were often considerable. As an example was quoted a yellow brass (70: 30) alloy made over a long period, which gave in the cold castings 76 per cent. copper and 24 per cent. zinc, these castings being unduly expensive since there was an excess of the costly copper and a deficiency of the cheaper zinc.

Regarding the losses of zinc, it was explained that the amount lost was not determined by the amount in the composition, but by the highest temperature reached. Illustrating the fact were quoted the following figures:—

	Highest Temperature. °C.	Zn. in Castings. Per cent.	Loss of Zn. Per cent.
Gun metal	1,173	1.8	27.7
Red brass	1,308	10.2	28.6
Yellow brass	1,182	26.0	26.1
Muntz metal	1,038	40.5	19.0

The exact working losses of zinc should be determined in the case of each alloy. When manganese or phosphorus were added to an alloy, decisive losses of these constituents occurred, the amount varying considerably, but generally from 30 to 50 per cent. This, however, was of only secondary moment, as their chief duty was the elimination of the oxygen; in some cases all the manganese or phosphorus was used up in this scavenging process, and none remained in the casting.

A further important feature was the speed of melting. The metals should be melted as quickly as possible, and never be allowed to lie in the fires in a molten condition longer than necessary.

Types of Alloys.

Dealing with types of alloys, the lecturer remarked that the copper-tin alloys used were not extensive, the chief being bell metal, Cu. 83.3 and Sn. 16.7. The copper-tin-zinc alloys were largely employed under the titles of gun-metals, machine brasses and valve metals. As examples of these alloys were quoted the following mixtures and the typical high tests obtained from them:—

	1. Per cent.	2. Per cent.	3. Per cent.
Cu.	88	86	87
Sn.	10	10	8
Zn.	2	4	5
Max. stress	18.0	17.0	16.5
Elongation % on 2 ins.	11.0	10.5	9.0

The first was generally conceded to be the best gun-metal mixture, while the second was a very good one; but by careful practice the third (old Admiralty gun-metal) could be made to give as good results as were generally obtained from No. 1. The speaker drew attention to a query in the columns of the FOUNDRY TRADE JOURNAL, in which the writer stated he had failed to get more than 10 tons maximum stress, and 6 per cent. elongation on 2 in. with the 88 :10 :2 mixture, whereas the Admiralty specification demanded 14 tons and 8 per cent. elongation. He (the speaker) could quite believe the statement as to the maximum results obtained by the querist, for he himself had obtained in the course of hundreds of tests results varying from 6.5 tons maximum stress and 3.7 per cent. elongation, to 20 tons and 16 per cent. elongation with the same Admiralty gun-metal, the composition in each case being identical.

Regarding the constituents of the brasses and bronzes, it was stated that lead improved the turning properties of alloys, owing to the fact that the lead was mechanically distributed through the alloy, destroying its continuity. Tin should not be present in quantities exceeding 10 per cent. if safety was of importance, except for bearings. Beyond 14 per cent. tin produced a brittle and hard alloy. As an example was quoted an alloy of Cu. 85, Sn. 13, Zn. 2, which gave a maximum stress of 11.9 tons, and elongation of only 1.5 per cent.

Phosphorus was added to bronze to give solidity and hardness in the case of bearing metals. At one time phosphor-bronze was extensively used for underwater fittings, but had been largely supplanted by steel. Examples of tests of mild phosphor-bronzes containing from 0.2 to 0.4 phosphorus were given as follows:—

	Max. stress. Tons.	Elongation. on 6 ins. Per cent.
1	19.0	18.8
2	20.7	36.5
3	21.5	33.0
4	22.4	27.0
5	26.2	51.0

The usual specification for this alloy was 17 tons maximum stress, and 15 per cent. elongation, while the lowest obtained by the lecturer was 12 tons and 15 per cent. elongation.

The brass trade, continued the speaker, was dominated by the 70 Cu. 30 Zn. mixture, this being one of the best. As instancing the effect of ascending quantities of zinc were quoted the following:—

Cu.	Zn.	Max. stress. Tons.	Elongation. on 2 ins. Per cent.
90	10	8	15
70	30	10	25
60	40	15	10

Endeavours had been made to combine the high elongation of the second alloy with the high strength of the third, and to this end other constituents (aluminium, manganese and iron) had been added to the latter. As a result an alloy known as manganese bronze had been obtained which gave 25 tons maximum stress and 30 per cent. elongation. It might be noted that although no manganese need necessarily be present in the finished casting, it was essential that both aluminium and iron be present.

Factors Influencing Success.

The speaker then proceeded to outline the chief factors or conditions influencing success or failure in the production of alloys, and tabulated them as follows:—Composition (freedom from chemical impurities); the correctness of the mould and its cores; the method of melting and the importance of not stewing the metal in the furnace; the casting temperature; foreign matter trapped in the mould; liquid shrinkage and later solid contraction, which, unless properly fed, would give pin-holes and other defects. Considerable stress was laid on the importance of the casting temperature as influencing the test results given by an alloy. As examples were quoted bars of Admiralty gun-metal, the first of which was cast on the metal being removed from the furnace, and the other two at intervals of two minutes. The results were as follows:—

	Max. stress. Tons.	Elongation. Per cent.
1	8.38	5.5
2	14.84	14.5
3	11.02	5.0

Examples were also quoted from the following interesting table:—

Alloy	Cu.	Zn.	Sn.	Casting temp. °C.	Max. stress. Tons per sq. in.	Elong. per cent. on 2 ins.
Gun metal ...	87.5	1.89	10.20	1173	8.38	5.5
				1069	14.84	14.5
				965	11.02	5.0
Yellow brass ...	73.0	26.0	—	1182	11.48	37.7
				1020	12.71	43.0
				850	7.45	15.0
Red brass ...	89.6	10.2	—	1308	6.85	13.2
				1073	12.65	26.0
				1058	5.67	5.5
Muntz metal ...	58.6	40.5	—	1038	12.45	6.0
				973	18.89	15.0
				943	16.29	9.5

Discussion.

At the conclusion of the address, a number of questions were put to the lecturer, evidencing the interest which had been aroused among London brassfounders.

MR. BRIER asked how to distinguish in ordinary practice between the various temperatures which were obtained in melting? For the last 30 years, he re-

marked, he had used sticks of hard wood for stirring the metal in order to deoxidise it.

Mr. Young asked whether it was better to melt the virgin metals and pour direct, or to remelt the alloy before casting?

Mr. Remington desired to know how a moulder could regulate the pouring temperatures when using a 60-lb. pot of metal to pour 17 moulds?

Mr. Otto: What is the percentage of loss on a 90 Cu : 10 Sn : mixture?

Mr. Florence asked what was the effect of plunging castings when blood hot into water?

Mr. Young desired to know how castings of commercially pure copper for electrical purposes could be made sound?

Mr. Beer: What percentage of manganese is required for German-silver castings?

Mr. J. Horne (Vice-President), referring to the 88:10:2 alloy, said that in the testing department with which he was connected the highest maximum stress obtained was 24 tons, and the highest elongation 35 per cent. He asked Mr. Longmuir for the scientific explanation of the considerable variations which were experienced in the same alloy?

Mr. Longmuir, replying to the various questions, said that a charcoal fire in the bottom of the ladle was very good, and gave excellent contact of the metal with the charcoal. The employment of a stick was simply an adaptation of the poling process, in which the copper or alloy was poled with a green stick to give the gases necessary to clear the oxides. This caused a disturbance of the metal, but the size of the stick should be commensurate with the size of the pot, the object being to get a steady stream of gases up through the metal rather than too violent an ebullition. As regards a member's remarks on aluminium, when that metal was used as a deoxidiser, flakes of alumina formed which were apt to be trapped in the casting and cause a dirty surface. In many cases, the only way to avoid this was by the use of plug heads; the heads were filled and the plug then lifted to allow the mould to fill cleanly. Replying to Mr. Brier, he could not say how to distinguish the failing temperature of a metal, as this temperature varied according to the size, shape, etc., of the casting. As regards the respective values of alloys and virgin metals, the made-up alloys gave decidedly better results, on the whole. He recalled the rate of working which had obtained in Clydeside foundries in his younger days, and regarded the problem propounded by Mr. Remington as not such a difficult matter as the speaker suggested. Replying to Mr. Otto, the lecturer stated that he had had no experience with the 90 Cu:10 Sn. alloy. On the subject of quenching, this matter, he remarked, was a big question; different results were obtained by different temperatures, but that could be better dealt with in a future Paper on the structure of alloys. The production of castings of pure copper was a question of the skilful use of deoxidisers. It might be possible to use such a quantity as would do the cleansing and leave none of itself behind. He reminded Mr. Young that the great majority of electrical castings for the purposes mentioned contained 2 per cent. of zinc. For German-silver, 0.5 per cent. of manganese to the amount of nickel used in the alloy would effectively deoxidise it. In regard to Mr. Horne's query, he did not feel inclined at the moment to go into the question of the differences produced by temperature effects. He might explain, however, that high temperature gave a loose (and consequently weak) structure of crystals in the alloy, as also did a temperature which was too low.

The meeting closed with a hearty vote of thanks to the speaker for his interesting lecture.

President of the London B.F.A.

So much of the foundry work turned out in the London district has intimate association with engineering work, that the selection of Mr. J. Oswald, M.I.M.E., of Messrs. J. Oswald & Son, Nine Elms, London, S.W., to be the first occupant of the Branch presidential chair would seem particularly happy, for he is primarily an engineer, the foundry having been his department only within comparatively recent years. The intimate knowledge of engineering requirements which Mr. Oswald's earlier training has given him should be extremely useful to the foundrymen with whom he is now working in the cause of progress.

Mr. Oswald was born in 1868, north of the Tweed, his father being a well-known engineer who carried out extensive irrigation works in Egypt and elsewhere. His education was started at Remleh, in Egypt, and on returning to England he received a grammar school training. This was supplemented by technical instruction at the Regent Street Polytechnic Institute, where he successfully passed the Science and Arts Departments engineering examinations. He then went through the shops of the well-known engineering firm of Messrs. James Simpson & Company, Limited, London, and was, at the conclusion of his apprenticeship, transferred to the outdoor department, in which he served three years. He then became engaged in his father's engineering and foundry business, and entered into partnership in the firm, in which he now holds the controlling interest. He is also the proprietor of the pattern-making business of Oswald & Potts, of Nine Elms, S.W. Besides being a member of the Institution of Mechanical Engineers, Mr. Oswald is on the Council of the Junior Institution of Engineers, in which he takes a very great interest. He is a member of the General Council of the parent body of the British Foundrymen's Association, and was the first London representative on that Council.

Mr. J. Oswald, M.I.M.E.,
President of the London Branch of the British Foundrymen's Association.

Hardness Tests on Alloys.

By F. H. Hurren.

During the past eighteen months the writer has been experimenting on the hardness of alloys, with a view to evolving a simple test of the suitability of various alloys for certain specified purposes.

The instrument which has been used is the Shore scleroscope. This instrument is, no doubt, familiar to most readers of this Journal, and the hardness is registered by the point to which a falling hammer rebounds when dropped from a certain height. The hammer is of steel, with a diamond point, and weighs approximately 40 grains, and the length of drop is about 10 inches. By means of a scale in the glass tube through which the hammer falls, the height of rebound is observed. For soft metals, a second hammer, called a "magnifier hammer" is supplied, and differs only from the ordinary hammer in that it has a steel point. A chart is supplied, by means of which readings with the magnifier hammer may be converted into comparative readings with the ordinary hammer.

For steels the value of the scleroscope is unquestionable, but for cast-iron and non-ferrous alloys the results have been frankly disappointing.

Aluminium alloys were first tested, and for these the use of the magnifier hammer is necessary. In Table 1 are given a few results of tests on different alloys, and it will be noticed that the hardness number recorded was in each case practically the same.

TABLE 1.

	1.	2.	3.	4.	5.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Copper	5.07	4.36	5.27	4.42	7.20
Zinc	12.42	4.94	6.10	3.77	10.60
Aluminium	81.46	89.40	87.78	90.62	81.30
Hardness	14	13	13	13	14

The alloys contained, in addition to the copper and zinc, small traces of silicon and iron. Very little of value can be deduced from the above figures, as a difference of one point in the hardness number is of no practical utility.

Gun-metals were next tested, and here again no useful information was gained. A number of mixtures were made up, and the hardness number and analysis of each carefully determined. Table 2 shows some of the figures obtained.

TABLE 2.

	1.	2.	3.	4.	5.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Copper	88.70	89.80	83.82	87.55	86.94
Tin	7.35	8.04	4.88	9.83	4.98
Zinc	1.75	0.25	10.05	2.32	7.48
Lead	0.40	1.62	1.15	Trace.	0.55
Hardness	20	19	19	20	19

It will be readily seen that wide variations in composition show little or no variation in hardness.

The next tests were made on phosphor bronzes, and some slight reward was met. It is generally understood that increasing quantities of tin and phosphorus give increasing hardness, and this will be seen from the results shown in Table 3.

TABLE 3.

	1.	2.	3.	4.	5.	6.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Copper	91.43	89.50	90.89	93.65	93.22	96.59
Tin...	8.06	9.11	8.93	6.12	5.31	3.29
Phosphorus ...	0.35	0.90	0.19	0.14	0.20	0.09
Hardness ...	29	31	28	25	24	21

It will be noted, however, that the approximate percentage of tin and phosphorus could not be determined from the hardness number. For instance, No. 3 has a greater hardness than No. 5, although it contains less phosphorus; the increase in hardness doubtless being due to the higher tin content of No. 3. On the other hand, Nos. 1 and 3 are of practically the same hardness, and yet No. 1 contains nearly twice as much phosphorus as No. 3, and nearly the same amount of tin. The hardness numbers given in Tables 1—3 were obtained with the magnifier hammer.

The next investigation was on cast iron, and here the writer must confess to unqualified failure to establish any direct relationship between hardness and chemical composition, although many interesting points were met. The reason for this failure is not hard to seek, as cast iron is of such a complex nature that small differences in the percentages of one or two constituents produce wide differences in physical properties. Apparently the field of investigation of hardness has not yet reached cast iron, as, with the exception of a Paper read by Mr. R. Mather before the Annual Meeting of the British Foundrymen's Association in August, 1910, the writer has been unable to discover any published details of tests of hardness of cast iron.

TABLE 4.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Comb. carbon	1.10	0.57	0.42	0.55	0.60	0.58	0.64	3.45	0.50	0.51	1.30
Graphite...	2.39	2.24	1.94	2.51	2.41	2.30	2.22	2.34	2.31	2.30	2.03
Silicon	1.50	2.35	2.96	1.77	2.09	2.09	2.44	2.57	2.73	2.87	1.65
Sulphur	0.17	0.03	0.04	0.06	0.10	0.06	0.09	0.11	0.09	0.09	0.18
Phosphorus	1.02	1.24	1.04	0.52	1.02	1.10	1.08	1.20	1.37	1.29	0.94
Manganese	0.82	1.33	1.44	0.80	0 61	1.13	1.21	1.03	1.02	1.04	0.48
Hardness	51	36	41	35	44	39	41	35	38	36	50

In Table 4, some analyses of cast irons and their hardness numbers are given. These hardness numbers are with the "ordinary" hammer.

The idea generally accepted by foundrymen is that combined carbon, sulphur and manganese increase hardness, graphitic carbon and silicon decrease hardness, and phosphorus has little or no effect on the hardness. Now examine Table 4, and see how these ideas agree.

Nos. 1 and 11, which have the greatest hardness, are very high in combined carbon; also in each case silicon

is low and sulphur high. These two, therefore, seem to agree with our theory. Now take Nos. 2 and 6. The combined carbons are practically the same, but No. 6 has the higher graphitic carbon and silicon, and a lower sulphur and manganese, all tending to reduced hardness, and yet No. 6 has a hardness number of 39, compared with 36 for No. 2. Then again, consider Nos. 5 and 7. The former has a lower combined carbon and manganese, and a higher graphitic carbon, all tending to softness; and yet it has a hardness of 44, compared with 41 for No. 7. The additional three points of hardness cannot be due only to the slightly reduced percentage of silicon which No. 5 carries, as Nos. 9 and 10, which differ only in their silicon content, have identical hardness numbers. No. 4, when compared with No. 8, which is of the same hardness, shows an increased combined carbon and decreased silicon, tending to hardness; but to counteract this, an increased graphitic carbon, and decreased sulphur and manganese. These differences apparently balance. Nos. 3 and 7 are equal in hardness, but show widely divergent analyses.

As before explained, the object of these experiments was to simplify the testing of materials in a foundry where a large number of alloys are made up for various purposes, chiefly connected with the motor trade. Various component parts in motor cars have to stand enormously different stresses, and for the sake of economy in manufacture, different alloys are necessary. This applies equally to gun-metal, phosphor bronze, aluminium, and cast iron, both from the actual life of the casting in everyday use, and from the machining shop's point of view. A good deal of time is taken up in the investigation of chemical and physical properties, in order to make certain the castings are up to specification. If a simple test, such as hardness, could be applied, in place of the lengthier chemical and mechanical tests, much time and expense would be saved.

Although, the writer was unsuccessful, in his opinion the want of success was due to the general lack of understanding between the chemical and physical properties of metals; and he has not lost hope that in the future the hardness test will rank with the tensile and transverse tests as a means of investigation into the utility of materials of construction.

The "Frick" Electric Furnace.*

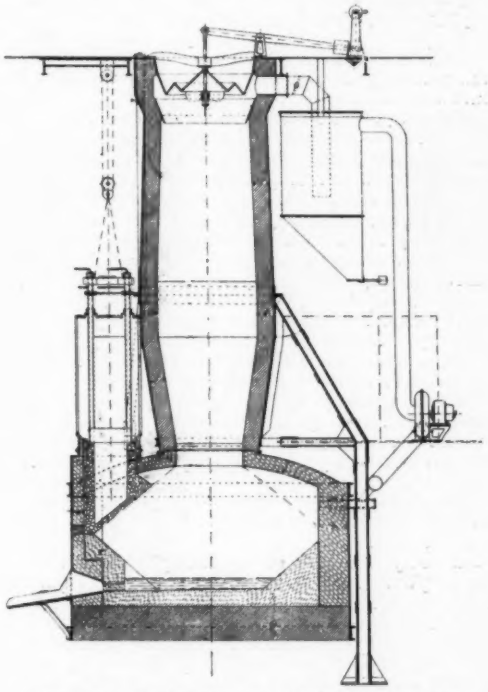
The Frick furnace for the reduction of ores belongs to the type of electric furnaces generally called "resistance furnaces," because of the material to be treated being used as a resister, heated by an electric current passing through it. The characteristic arrangement of this furnace refers to the electrodes. These are surrounded by loose charcoal or coke, and thus not only protected from combustion by the ore, but also insulated against heat losses, which are considerably reduced.

The accompanying section shows a furnace of 2,000 kilowatts, and is self-explanatory. The furnace is provided with two or more smaller shafts for the introduction of the electrodes. These latter shafts are provided with openings, through which part of the reducing agent, coke or charcoal, is fed so as to surround the electrodes and to protect them from oxidation For convenience, these openings are connected by means of small funnels with the top floor, so that the coal may be supplied from there to the electrodes.

*From a Bulletin issued by the Canadian Department of Mines.

The furnace represented on the drawing is designed to be worked with a two-phase current, the two phases being independent of each other. The reaction chamber is lined with magnesite. The diameter of this chamber has to be comparatively large to obtain a sufficiently high resistance and to avoid a too excessive current. This is the opposite of the ordinary blast furnace practice, according to which the furnace is made narrower in the melting zone, mainly with a view to enabling the blast to reach the centre of this zone.

Besides the openings in the wall for tapping of pig and slag, openings are provided, one in front of each electrode and one or more between the electrodes. Through the former the charcoal or coke round the electrode may be raked out when an exchange of electrodes has to be made. The latter may serve for the introduction of gas taken from the furnace top by a fan, with the purpose of using the gas as a heat



SECTIONAL ELEVATION OF "FRICK" ELECTRIC REDUCTION FURNACE.

transmitter, so as to increase the extension of the hot zone, within which a reduction of the ore by carbonic oxide can take place. This circulation of the gas was first proposed by Harmet. The main shaft is carried by a special steel beam construction, in a similar way to that used in ordinary blast furnaces, so as not to rest on the roof of the lower chamber. A sand closing between main shaft and roof prevents gases from escaping this way. On account of the small amount of gas produced in the electric furnace (six to seven times less than in the ordinary blast furnace), the height of the main shaft does not need to be so great For a 2,000-kilowatt furnace, 6 metres, or 20 ft., will prove quite sufficient in most cases. The top of the shaft may be closed by any suitable blast furnace top. The drawing shows a "Charleville" top, as used in Sweden.

Notes on Foundry Efficiency.

Address before Scottish Foundrymen.

On Saturday afternoon, April 8th, the Scottish Branch of the British Foundrymen's Association held their final meeting for the Session in the Technical College, Glasgow. Mr. Wm. Mayer, of the Leven Bank Foundry, Dumbarton, the Senior Vice-President, occupied the chair, and there was a very large attendance of members.

Mr. H. Pemberton, Derby, read a most interesting Paper, illustrated by lantern views, on "A Few Notes on Foundry Efficiency." At the outset the author said it was necessary that the foundry foreman or manager should have complete control of all the material coming into the foundry so that he might regulate the supply of any one article, such as a particular brand of pig-iron. Moreover, in the production of castings too much attention cannot be paid to the mixing of the various grades of facing sands, as one sand mixture cannot be made to meet all the requirements of the foundry. In selecting sands for facing, of which there are three or more strengths, varying chiefly in alumina, thickness of metal and depth of casting must be considered. Although a good blacking will resist ...ote of the metal when thick, deep castings are made, a sand sufficiently strong in alumina must back it up to prevent fusion taking place with the fusible silicates in the sand. In producing castings there are three ways by which they can be made, namely, in loam, dry sand and green sand. He (Mr. Pemberton) preferred in the course of the present Paper to show two ways of making various castings in green sand. Castings made in this manner are what might be called "common castings," and they are mostly made in three ways, either by having the pattern loose, or mounted on to a plate or on to a machine. Small articles are usually made with a loose pattern when there is not a large quantity required, but when 100 to 200 are in demand, and likely to be repeated, even in much smaller quantities, then the most efficient thing to do is to mount the pattern on to a plate for machine moulding.

An easy method of mounting a pattern on to a plate for machine or plate moulding, is the following. First, a moulding box is required about 8 in. larger than the pattern plate that is to be made. The top half of the box is filled with sand, and the patterns placed carefully on this up to the parting line. The bottom half of the box is then placed on the top half and facing sand is put around the patterns. The bottom half of the box is then filled up with old sand, which is rammed up and rolled over. Subsequently the joint of the mould is very carefully made, and the patterns are lifted out of the bottom mould to insure accuracy of the parting line. These are then replaced and parting sand is dusted on the point of the mould. The top half of the moulding box is thereafter put on the bottom half and facing sand is placed over the top half of the patterns. When the box is filled with old sand and rammed up to the top half of the mould, it is parted, the patterns are withdrawn, and the moulds finished with great care. A frame, the thickness and size of the plate required, is placed around the moulds and a second frame of equal thickness is placed on the edge of the moulding box. The space between these two frames is filled with old sand and sleeked level. The smaller frame is withdrawn from the sand, and the larger frame left on the edge of the moulding box. When the mould is closed the top half is separated from the bottom by the thickness of the frame which has been left on the edge of the moulding box. The mould is then cast, and after a little scurfing up the plate is put to warm, and then it is brushed over with beeswax, or given a coat of shellac. When it is dry, the plate pattern is ready for working off. The time taken to do the whole of the work is usually about a day and a half for a pattern plate 16 in. square.

Having described two ways of making a small casting, the author by the aid of lantern views illustrated the efficiency in the production of a combination of plate and machine moulding for the one article. He also showed two methods of moulding a locomotive chimney, the old and the new, and finally gave details of the moulding of a 10-in. oil gas retort. Passing on to deal with the questions of the management and the division of labour, Mr. Pemberton remarked that these, no doubt, were contentious points; but probably the best plan was to have a head foreman who had complete charge of the foundry under the supervision of the works manager. He thought, however, that the appointment of an under-foreman should be left largely to the discretion of the head foreman. The works manager should consult the head foreman with reference to all the material required for the foundry, such as the best brands of pig-iron to buy, the quality of coke, etc. Whether this system could be improved upon by the introduction of a metallurgist was a matter for consideration.

In the division of labour it was the best plan, where repetition work was required, that was, either plate work, machine work, or a combination of plate and machine, to have a set of moulders doing nothing else but moulding, a second set of men casting the moulds, and a third set taking the cramp off the moulds, shaking out the castings, taking them to the dressers and mixing the sand for the moulders. By this method a very much larger output of castings per square foot of floor space was obtained. As regards power and light, if it could be arranged to have a supply of power from the works, and be relieved from the trouble of raising its own motive power, this was, no doubt, the most convenient and efficient thing for the foundry. Electric power would be very serviceable and handy for a number of purposes apart from travelling cranes, but electric energy would not, however, be the best for every purpose. Possibly by using electricity and compressed air all the various appliances in the foundry could be economically and efficiently operated. On the matter of equipment he (the speaker) ventured to give the following list of appliances as being necessary to make a foundry efficient—two cupolas, travelling crane, three or four jib cranes, cupola hoists, motors, pressure blowers or fans, sand-mixing machines, rattling machines, emery wheels, sand blast, chipping hammers, core machines, core stores and moulding machines. There was no question that upon the management of the cupola depended largely the efficiency of any foundry, for if moulders were kept waiting for the molten iron after the moulds were ready, that was not economy, but very often meant the conversion of a profit into a loss. Therefore a cupola should always be large enough to meet the demands of the foundry. He did not wish to go into the details of the management of a cupola, but he would say that one melting 30 to 40 tons of iron per day should do so with 1.5 cwt. of coke per ton of iron

melted, and this should include all the coke used for lighting, while 40 lbs. of limestone and 36,000 cubic feet of air per ton of iron melted should be sufficient.

Some discussion ensued on the figures quoted by Mr. Pemberton showing a cupola efficiency of 1.5 cwt. of coke per ton of iron melted. The lecturer, however, gave the explanation that this efficiency was due, not so much to any special feature in the construction as to the careful regulation of the blast pressure, and the amount of air blown in not exceeding 36,000 cubic feet per ton of iron melted provided that ample limestone was also added as flux.

Manganese Steel.*

By F. E. Johnson.

The two chief factors in manganese steel are manganese and carbon. One has to be very careful in its manufacture to see that the percentages of these are in the right proportion; too much carbon and not enough manganese makes the steel very stiff and brittle, therefore it does not possess the quality desired for this metal, and that is resistance to abrasive action which results from the combination of strength and ductility. There have been many mixtures experimented upon containing such ingredients as chromium, aluminium, tungsten, nickel, copper, titanium, vanadium, and other metals, with some good results, especially the mixture containing chromium and vanadium, as both these metals raise the elastic limit of the steel; but at present commercial manganese steel is practically a steel containing around 10 to 15 per cent. manganese and 1 per cent. carbon, without addition of any of the above metals mentioned.

Manganese steel is considered as being a very hard metal, due to the fact that it cannot be machined as readily as other steels or chipped with a cold chisel to any great extent; in fact, it is almost a useless task to attempt to cut or drill it with even the highest quality of tool steel. Tests made on the sceleroscope scale show Bessemer rail hardness of about 30, manganese steel 40 to 50, and chilled cast iron 65 to 70, and yet it has been demonstrated many times that manganese steel will outwear either of these metals many times over.

The electro-magnet has no effect upon manganese steel containing a certain percentage of Mn. and over, and it will not become a permanent magnet by having a current passed through it magnetising it; hence its use for disks in magnetic cranes, as the smallest particle of iron or steel will not cling to it after the current is shut off.

The greatest characteristic of manganese steel is its resistance to abrasive wearing action, which is due to its ability to flow or endure repeated distortion of its wearing surface. The steel is composed chiefly of a mixture of scrap iron and pig, this mixture being very carefully made up according to analysis. This is melted in an ordinary cupola, such as any foundry uses, and is then run into a converter and blown quite similarly to Bessemer steel. This process, however, is very delicate and is attended to by one man only, who operates everything from the central station or platform close to the converters. After it is blown it is poured into large ladles from which the slag is removed, and the manganese, which has previously been melted in graphite crucibles under very intense heat, is then added. From these large ladles it is poured into sand moulds, which are practically the same as ordinary cast-iron moulds. The main thing to take care of is the excessive shrinkage when cooling, as manganese steel shrinks five-sixteenths of an inch per foot, while ordinary cast iron only shrinks one-tenth of an inch per foot. Also in the manufacture of manganese steel there has to be cast into the castings very often soft steel bushings and inserts wherever it is necessary to bore out, drill or tap the casting for finishing, such as hubs of car wheels, crane wheels, cutting of key seats, putting in set-screws, etc. It can be seen that the casting in of these inserts is quite a difficult task, because they must not only be in their proper position, but must be so cast in that they will not work loose—and this with the excessive shrinkage makes it very difficult to get a satisfactory casting.

All ladles and moulds are kept very hot, so as not to chill the metal before it is poured, as it is absolutely necessary to have a homogeneous casting free from all blow-holes and other defects, because manganese-steel castings are used where great strains and shocks are experienced.

So far the manufacture is quite simple, but the difficult part now comes, as all castings are treated either by heat treatment or both heat treatment and water submergence. Manganese-steel castings can only be successfully made to certain sizes as to lengths, and particularly area of cross-sections, where the thickness is a prime factor. The greatest thickness of any section that has been successfully cast up to date is about 4½ in. The writer has seen 5-in. roll shells, but they did not wear so well. It is also very difficult to cast in small or thin sections, the limit being about ⅜ in. thick for ordinary castings such as car wheels, small lining plates, etc.

After the castings are taken from the moulds and treated, they are removed either to the grinding shed or machine shop, where all finishing work is done. In cases of castings where no finishing work is required, they are simply rough finished by means of carborundum wheels attached to movable or swinging frames, on which is also mounted an electric motor for driving the wheel. This arrangement is for grinding large and heavy castings. For small castings the regular grinder stand is used, and in cases where it is necessary to get into corners the wheel is connected to the motor by a flexible shaft.

In the machine shop the planer, lathes, etc., are equipped with carborundum wheels whenever the finish has to be done out of the manganese steel itself. However, in cases of soft-steel bushings and inserts, the work is done by the usual machine-shop practice.

The smallest hole that can be finished or ground out of the manganese steel is about 2 in. diameter, but this very seldom has to be done, as in very nearly all cases where castings have to be machined for shafts, pins and key seats, it can be done by putting in soft-steel bushings. Coring the castings is resorted to as much as possible so as to save in cost of manufacture. In case of roll shells, for instance, where they are put on the centres by means of taper cores, they have to be finished inside diameter, and that necessitates a great deal of work because the finishing has to be done on the manganese steel itself, and it will take a first-class grinder about three days to finish up one shell of 36-in. diameter by 15-in. face.

Manganese steel has made it possible to cut down the maintenance cost very materially for many machines. Take, for instance, the steam shovel. There are used on the dipper teeth which have until recently been made from solid forgings, and by being able to cast a metal of the toughness of manganese steel it is possible to make these teeth generally in two parts, and thereby it is only necessary to renew the points, the bases lasting almost indefinitely.

D

* Abstract of Paper read before the Utah Society of Engineers U.S.A.

Some Alloys of Aluminium.

By Fred C. A. H. Lantsberry, M.Sc.

(*Continued from page* 206.)

Aluminium-Magnesium Alloys.

Magnesium appears to be an ideal element to add to aluminium, primarily because of its lightness, its specific gravity being only about 1.7, and secondly because of its power as a deoxidiser being greater than that of aluminium itself. The alloys were first discovered by Wöhler in 1866, later by Parkinson in 1867, but the first to investigate them at all thoroughly was Dr. Mach, who called the metal magnalium. The alloys examined contained from 10 to 30 per cent. of magnesium, and the harder ones are capable of taking a very high polish, capable of rivalling that of pure silver. Further, the alloys show a high resistance to atmospheric influences and retain their polish for a long time. Consequently they find application in the manufacture of scientific instruments.

Between 15 per cent. magnesium and 15 per cent. aluminium, the alloys are too brittle for constructional work, for which purposes magnesium is usually used in conjunction with other metals. Two alloys which find some application in the arts have the compositions:—

	X. Per cent.	Z. Per cent.
Copper	1.76	0.21
Nickel	1.16	—
Lead	—	0.72
Tin	—	3.15
Magnesium	1.60	1.58
Aluminium	95.48	94.34

In the form of castings the second alloy has a tensile strength of 14 to 21 tons per sq. in Both alloys work well, and in drawing require to be frequently annealed, followed by rapid cooling. Tin is said to reduce the shrinkage, enabling sharp castings to be obtained.

Aluminium-Nickel-Alloys.

Nickel behaves like copper, but the high nickel alloys possess, like the manganese alloys, the faculty of falling to powder in the atmosphere. Alloys containing above 5 per cent. nickel are brittle, but a 2 per cent. alloy casts and rolls well, giving sheet with a strength of 12 tons per sq. in. and an elongation of 20 per cent. The Pittsburg Reduction Company, however, claim that in the construction of the "Defender" an aluminium-nickel alloy having a tensile strength of 30,000 to 45,000 lbs. per sq. in., and an elongation of 10 per cent., was used. The alloys rapidly corrode in water.

Tungsten appears to be a useful element to add to aluminium, especially for alloys which have to be rolled into sheet, etc., and a most interesting alloy of this nature is wolframium which appears to have the composition:—Copper, 0.357 per cent.; tin, 0.015 per cent.; antimony, 1.442 per cent.; wolfram, 0.038 per cent.; aluminium, 98.040 per cent.

In the hard-drawn condition the alloy has a tensile strength of 23 tons, with an elongation of about 10 per cent. On annealing the tenacity falls to 16 tons with an elongation of 15 per cent.

Duralumin.

Duralumin was originally discovered in Germany and has lately been very much boomed in this country by Messrs. Vickers, Sons and Maxim. The alloy is not specially suitable for castings, but it finds its main uses in the form of wire and sheets. It is claimed that the material can be obtained in strengths varying from 26 to 40 tons per sq. in. with elongations varying from 3 to 21 per cent. and Brinell hardness numbers of from 100 to 174, according to the degree and manner of working. The alloy is capable of taking a very high polish and resists atmospheric corrosion very well. The author has made several analyses of the material and its mean composition appears to be:—Copper, 3.58 per cent.; silicon, 0.53 per cent.; iron, 0.63 per cent.; manganese, 0.43 per cent.; aluminium, 94.87 per cent.

There are also indications of the presence of magnesium, which has possibly been used as a deoxidiser. Other analyses show somewhat less manganese and more magnesium, one authority giving the magnesium content as high as 0.75 per cent. Apparently there is some variation in the composition, but the writer has never been able to detect so large a quantity of magnesium in any of his samples. Tensile tests on a sheet of the material, 0.082 in. thick, showed that it had a yield point of 56,000 lbs., an ultimate stress of 66,000 lbs. per sq. in. with an elongation of 2 per cent. A wire 0.057 inches diameter broke at 180 lbs., equal to a tenacity of 70,500 lbs. per sq. in. A sample of the sheet after boiling in water for 4 hours appeared to yield from the commencement of loading and finally broke under a stress equal to 58,500 lbs. per sq. in., with an elongation of only 3 per cent. After annealing at 260 degrees C. for half-an-hour the strip showed a tenacity of only 51,200 lbs. per sq. in. with an elongation of 3 per cent. The wire after annealing at 260 degrees C. for half-an-hour broke at 160 lbs., equal to a tenacity of 63,000 lbs. per sq. in.

Discussion.

The PRESIDENT (Mr. Hiorns), in opening the discussion, said: I think it will be seen, from what Mr. Lantsberry has said, that the number of metals that can be alloyed with aluminium to produce useful alloys is very limited. By useful alloys, I mean those which can be rolled and drawn into wire and, generally speaking, worked. The limited number of useful alloys of aluminium arises from the fact that all alloys may be considered under three categories. First, there are those alloys which form solid solutions, (*i.e.*, one metal is dissolved in the other just as salt is dissolved in water and remains a solid). It is a remarkable fact that all useful alloys which are used in industry are solid solutions. Metals can also unite by forming chemical compounds. A chemical compound is hard and brittle, and aluminium is a substance which most readily forms a chemical compound with any other metal that may be mixed with it. Now, if these chemical compounds can be dissolved in another metal, then a useful alloy is formed. There is another category which may be called eutectic, where the two metals unite together to form eutectics, these eutectics being for the most part brittle bodies. With regard to aluminium, the difficulty arises from the fact that it most readily forms chemical compounds, and thus produces brittle alloys. But in certain cases aluminium forms solid solutions and, therefore, produces useful alloys. In Table 2 of the Paper is quoted a

† Paper read before the Birmingham Branch of the British Foundrymen's Association, March 25.

10 per cent. alloy an ultimate stress of 26 tons per sq. in. and an elongation on the annealed specimen of 27 per cent., and on the quenched of 22 per cent. But later it is stated that Messrs. Carpenter and Edwards, when they took mechanical tests of cylindrical castings nine inches long and three inches diameter, obtained results showing that a 10 per cent. alloy had an elongation of only 13 per cent. Perhaps Mr. Lantsberry may be able to explain why these tests should give a different elongation. Then I notice in the following paragraph that the effect of mechanical work on the alloys, with a reduction from $\frac{5}{16}$ths to $\frac{3}{16}$ths diameter was to give increased stress result; and then, in another case, the effect of hot rolling from three inches to th increased the tenacity and ductility of the alloy. Perhaps, Mr. Lantsberry will explain that matter. It is also stated that: "Alloys containing below 7.5 per cent. aluminium are not amenable to cold working, but the higher alloys draw well and show a vast improvement in their mechanical properties." On referring to Table 2 above, I find there is a 5 per cent. alloy which gives 80 per cent. elongation. That, I think, also requires some little explanation. I notice further down, that under the alternating stress test, alloys showed almost marvellous results. Will Mr. Lantsberry tell us what these marvellous results were. Then we should probably like to have a description of the Izod test. The author also refers to a recent research of Messrs. Carpenter and Edwards as showing that if sound castings of these alloys are obtained, they are eminently suitable for the production of castings to withstand hydraulic and steam pressures. It is a well-known fact that aluminium bronze is one of the worst alloys to stand high temperatures, and I think high-pressure steam probably would have a considerable influence in pitting such alloys. It does not seem to me quite the right alloy to use for these purposes. Perhaps Mr. Lantsberry can tell us what temperature these castings were subjected to. Then it is stated that one of the chief difficulties encountered in dealing with these alloys lies in the formation of a dross or skin of alumina, which appears to be almost elastic and defies all efforts to remove it. This alumina, we are told, is produced partly by the reduction of copper oxide and partly by atmospheric oxidation, and, therefore, it was considered that the difficulty could be at all events partly removed by reducing the copper oxide before adding the aluminium. Mr. Lantsberry tells us that he, accordingly, in conjunction with Dr. Rosenhain, took up the matter and studied it on these lines. There is a point with regard to this. Why, where borax is used as a covering and that is saturated with manganese oxide, is that manganese oxide introduced in the borax, seeing that a quantity of manganese is afterwards to be added? Again, it is stated that the alloys with manganese are extremely hard, and the author expresses the opinion that they should find some application as bearing metals and would undoubtedly prove less expensive than phosphor bronze. The question is, would they really be less expensive than phosphor bronze? Moreover, with regard to bearing metals, it is not an advantage to have the bearing too hard. There is a reference to the effect that these alloys unfortunately possess a very low modulus of elasticity, which tells against them in their use in the construction of machinery, more especially in the rapidly moving parts. The modulus of elasticity ranges about 14 by 10^6 lbs. per sq. in. which is only half the figure given by steel, and this, we are told, explains the remarkable failure of the aluminium bronzes under dynamic stresses. Will Mr. Lantsberry please explain that statement a little more fully. With regard to Duralumin we find that the smaller the number of metals in an alloy, as a rule, the better is that alloy for useful purposes. Duralumin contains copper 3½ per cent., and silicon 0.25 per cent. Silicon is not one of the elements which form useful alloys with aluminium, but rather the reverse. Then there is iron 0.63 per cent., another metal which does not form good alloys with aluminium, and again, manganese 0.43 per cent., and this constituent, it is pointed out, has a hardening effect. As far as I have been able to gather, there are only four metals which can be alloyed with aluminium, and of these three in small quantities only. In fact, zinc is practically the only metal which can be added in any large quantity to form useful alloys with aluminium, and the other three are magnesium, nickel and copper. It has been pointed out, too, that the quantity of copper that can be usefeully alloyed with aluminium is limited, but I suppose the ductility tests were made by drawing wires. A still better test than drawing wires, a more severe test, is by getting the rolled sheet and drawing it into envelopes. Some years ago I tried the effect of copper with aluminium for cartridge cases. Those connected with that trade will know how extreme is the work to which the metal is subjected. The blank is passed through six or seven drawings without any annealing whatever, and then the nose is put on before the case is finished. That is a very severe test, and I find I can make excellent tubes like that out of about 6 per cent. copper, but beyond that they begin to fail. Mr. Lantsberry, however, says that 4 per cent. is the limit of useful alloy of copper with aluminium. I think in work for rolling or drawing we may safely go as far as 6 per cent., but I think Dr. Carpenter's 8 per cent. is a good deal too high. You cannot go safely past 6 per cent.

Professor T. Turner (President of the Birmingham Metallurgical Society): A 10 per cent. copper-aluminium alloy was made by Dr. Percy when he lived in Great Charles Street, Birmingham, so that we may regard the 10 per cent. as the first important alloy of aluminium. Those who can look back about thirty years will remember that there was a kind of snake watch-chain that was very much in favour in those days. It was made of rolled aluminium alloy, 10 per cent., I believe, though I never saw the analysis. I have one of those chains and it has retained its lustre for thirty years. It is of a bright yellow colour and during that period has shown no signs of ageing, although it is made of thin, rolled metal. Some of those present will probably also remember that Webster had an interesting method of preparing aluminiums which was conducted at Yardley Wood, near Birmingham. The aluminium was prepared from the chloride of aluminium by passing chlorine over precipitated alumina mixed with carbon. At Oldbury, also, there was an important factory, and if electricity had not been introduced for the work about that time, I think we should have been the largest producers of aluminium, though the cost would undoubtedly have been greater at the present time. I may mention one point in reference to the corrosion of these aluminium alloys. If I remember rightly, experiments were made fifteen or twenty years ago on the construction of torpedo boats with aluminium-bronze, consisting of aluminium 10 per cent. and the rest copper. The construction of those boats with aluminium was abandoned, although they were light and strong, on account of the corrosion, in fact, in a few months corrosion completely destroyed the ship. (Mr. Parker: One was lost on the French coast). Therefore, I do not quite appreciate the statements that there is no doubt that aluminium-bronze resists corrosion better than Muntz's metal or certain other alloys. It may have been so under the conditions of Mr. Lantsberry's experiments, but it does not seem to me to be so on a large scale. Another important point is the question of ageing or loss of worked hardness in alloys at the other end of the series. If you take an aluminium alloy, roll it, and put sufficient work upon it you will practically double its strength. There is

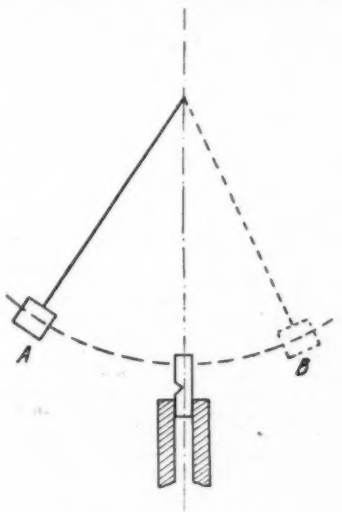
no doubt, as partly indicated in the Paper, that such alloys would be very susceptible to heat treatment, and a moderate temperature must either at once or in time considerably diminish the added tenacity, bringing these light white alloys back to the annealed condition. We know, as a matter of fact, that the annealing point of an alloy is always somewhat below, but fairly near to, its melting point, and since aluminium has a relatively low melting point it is perfectly obvious that its annealing point, and that of its alloys, must be somewhere in the neighbourhood of 300 deg. C. It may be below that and cannot be above it, so that superheated steam, for example, would tend very rapidly to age these alloys. Until we have had a longer period of work on some of these high tenacity light alloys, one should, I think, receive them with a certain amount of caution.

Mr. W. B. Parker (Rugby): With respect to Tables 1 and 2, I notice what is called the yield point. The term, "yield point," is very misleading when applied to copper alloys. As a matter of fact, with one or two exceptions, there is no definite yield point in any copper alloys that I know of, in the sense in which we use the term when referring to yield point of a metal like steel. Therefore, these figures are very misleading as regards the strength of the material. If you take the *true elastic limit* of these copper-aluminium alloys, you will find it very rarely to be above nine tons per sq. in., and generally, in the cast condition at any rate, it is only about six tons per sq. inch, especially if the castings are of large section and so cool down rather slowly. In this respect, these alloys compare very unfavourably with good manganese-bronze. That will give nine to twelve tons per sq. inch, *true elastic limit*, and when chilled this can be raised to 14 or 16 tons per sq. inch. For this reason, I do not recommend aluminium-copper alloys for such things as steam valves or hydraulic castings, etc. The pressure of superheated steam would be about 150 lbs. per sq. inch, and the temperature something like 230 deg. C., and under these conditions, from my experience, these alloys are unsuitable. In respect to the alloys mentioned as coming from Germany and containing iron, it is not clear whether this was one of the heavy copper-aluminium alloys, or one of the light aluminium-copper ones. But I suppose it is one of the heavy copper-aluminium alloys. I also have had experience of one of these alloys, but it came from France. It had 88 per cent. copper, 3 per cent. of iron, and 9 per cent. aluminium. Now, this alloy was absolutely no improvement on the ordinary plain 10 per cent. aluminium alloy as regards physical properties. It forged readily, whilst the heat treatment had little more influence on the alloy than it would have had with the pure form of the alloy, but it would not fall to pieces in any way. It was a very exceptional alloy in that respect. If to zinc be added about 12 per cent. of aluminium, a nice casting material is obtained, but, generally speaking, it is untrustworthy, it tends to fall to pieces, whereas with 58 to 60 per cent. of aluminium in zinc, it does not fall to pieces so readily, and a very strong alloy is got. But it has another very funny property, that is, of warping. When it is exposed to big changes of temperature or to dampness the castings in time warp, so that if used, say, for gas meters or electric meters, or anything of that kind, the parts get out of alignment and the meter comes to a standstill. I think it was this alloy Mr. Lantsberry referred to when talking of meter castings. One reason for this warping probably is that the castings are extremely thin, about $\frac{1}{4}$th inch, and, of course, very difficult to cast. I do not think the true explanation of this phenomenon is known, but I have been rather inclined to ascribe it to the iron and silicon in the aluminium used. I should like to know whether Mr. Lantsberry can give us a maximum figure for iron and silicon in ingot aluminium. Some makers are willing to take a contract for 99.5 per cent aluminium, while others will only guarantee 99 per cent., and others only 98.5 per cent. It is of growing importance that we should have some specification for ingot aluminium for foundry uses. I notice a comparison made between the 0.35 per cent. carbon steel and 10 per cent. aluminium alloy. The yield point for a 10 per cent. alloy sand casting is given as 15 tons per sq. inch as compared with 15 tons per sq. inch for the steel. But the steel of that carbon content in the forged condition would have from 18 to 20 tons per sq. inch elastic limit, and, if heat-treated, could be got up to 25 tons per sq. in. and yet retain 20 per cent. elongation, so that the copper alloy is decidedly inferior to the steel. With respect to the copper-magnesium-aluminium alloy containing 10 per cent. aluminium, 2 per cent. manganese, and 88 per cent. copper, it is claimed by the discoverer of this alloy that it possesses a yield point of 41 tons per sq. inch, and an ultimate stress of 52.1 tons per sq. inch with 10 per cent. elongation, when in the cold drawn condition. This will be a valuable alloy, especially if it can withstand for a long period of time a temperature of 200 deg. to 250 deg. C. Would it under these conditions tend to lose its strength, and if so, does Mr. Lantsberry think it would fail in twelve months or last something like a lifetime? The reason I ask is this; the turbine industry of the present time is calling urgently for a metal which would give a good *true elastic limit*, say, not under 18 tons per sq. in., and would *not lose* that under long contact with superheated steam, which, as I pointed out, has a temperature of about 233 deg. C. With respect to Duralumin, my own opinion is that there is no magnesium in it, but that it contains 0.5 per cent. of manganese. I think the remarks in magazines about its containing magnesium probably result from printer's errors for manganese. The structure of this alloy is rather peculiar. It is duplex, that is to say, there is a white constituent surrounded by an eutectic material, or what is probably an eutectic mixture; but I had it only in fine-rolled sheets and could make very little of it. It will not stand heat treatment, such as annealing; that is, it ages very quickly. There seems to be very little likelihood of such a high-melting point metal as vanadium being alloyed with aluminium alone, owing to the fact that the melting point of the two metals are so very different. That of vanadium is believed to be 1,300 deg. C. above the melting point of aluminium, so that it is a very big factor in the problem of introducing them, that is, in any large percentage.

Mr. Donald M'Levy (Birmingham University): There is only one point in the Paper to which I should like to refer, and that is in regard to the ageing properties of the lighter aluminium alloys. It frequently occurs in the case of alloys that as the more electro-positive end of the series is reached, the constitution becomes much more complex, and secondary changes may occur in the alloys. I believe that the "ageing" may be connected with these transformations; that it exerts a very powerful influence has been shown by Mr. Law, who has conducted a good deal of work on these alloys, and has found that some of them disintegrate to a remarkable extent. That this may conceivably be the case with simple alloys which we usually regard as solid solutions, such as the alpha solid solutions mentioned in the Paper, is also possible, since recent work has shown us that several of these alloys are not so simple as they were thought to be, and that some such transformation in a solid solution even occurs in the 70: 30 brasses.

MR. H. COE: My acquaintance with this subject has been chiefly in connection with the aluminium-zinc alloys, a research on which was published by Professor Turner and Mr. Ewen. About a year ago, Mr. Ewen found an arrest in certain of these alloys at about 225 degrees C., and some time afterwards I read an abstract of a paper by Mr. E. F. Law indicating that these alloys, when slowly cooled, disintegrated in course of time, while the quenched alloys remained unchanged. The connection between these facts and the inversion at 225 degrees C. (which has been confirmed recently by Dr. Rosenhain) seems obvious. Messrs. Shepherd and Bancroft specially refer to the care necessary to avoid the introduction of silicon into these alloys—for example, silicon absorbed from the pot in which the alloy was melted—and I am sure we should all be interested if Mr. Lantsberry would give us his experience with regard to this question, in connection with other alloys.

MR. LANTSBERRY, in reply, said: I quite agree with Mr. Hiorns that the problem in these light aluminium alloys is to get some solution for the compounds which aluminium is so prone to form. Mr. Hiorns referred to the point that the 10 per cent. aluminium alloy



ILLUSTRATING IZOD'S TEST.

showed inferior mechanical properties in large castings, as compared with small castings. I think the explanation lies in the fact that it is much more difficult to get large castings sound. Large castings have the happy knack of cooling at a slower rate, which further reduces their mechanical strength. Certainly I should say that the fact of the alloy having given lower elongation is due to the fact that the bigger casting is not so sound as the smaller one, and we see that the effect of annealing these alloys is to reduce slightly the elongation of the material. Mr. Hiorns, again, has asked about the 7.5 per cent. alloys which I said are not amenable to cold working. Perhaps amenable is not quite the word. I should have said that the mechanical strengths of the low aluminium alloys are not increased by cold working to anything like the same extent to which the mechanical strengths of the high alloys are. Then Mr. Hiorns asked what I meant by "marvellous results." I merely quoted Professor Arnold, and "marvellous results" means that these alloys showed a very much increased resistance to alternating stresses over the steels which Professor Arnold had examined by the same tests. With regard to the Izod test, the specimen is notched, placed in a vice, and broken by one blow of a pendulum hammer. The difference between the swing at "A" and at "B" (see sketch) is a measure of the energy absorbed in fracturing the bar. Borax, saturated with oxide of manganese, was used only in the preparation of the cupro-manganese and not in making the actual alloys, the object being to oxidise the impurities out of the "thermite" and ferro-manganese as far as possible. With regard to bearing metals, I did not mean to indicate that these alloys should supersede the white metals, for which there will always be a use, but I think that the 10 per cent. aluminium alloy containing 2 per cent. manganese might act as a substitute for phosphor bronze, and I think Mr. Hiorns will agree with me that a bearing bronze containing 10 per cent. of aluminium would be cheaper than one containing 10 per cent. tin. This manganese would be introduced as copper-manganese which is not very expensive—I do not think anything like so expensive as tin. It would take too long to go into a discussion of the difference between static and dynamic tests, but in the static tests the metal is broken by one application of the stress; that is, the stress is always in the same direction, whilst in the dynamic tests the stresses alternate first in tension and then in compression. Professor Turner asked why I say that the aluminium alloys resist corrosion very well. The method of testing these alloys for corrosion was to attach them to a board singly and also bolt them to steel plates and suspend them in sea-water for a period of over two years. Pure alloys were used, and were kept quite stationary. Under these conditions they showed little tendency to corrode. The method has been criticised, because of the view taken that under such conditions a protective coating of alumina is formed in the early stages, and hinders further corrosion. Rapid movement of the specimens would possibly remove this coating, but I have had no opportunity of testing this point. It is a subject upon which further information is wanted, and there is room for a corrosion test on metals moving through the liquids with more or less rapidity. I quite agree with Mr. Parker that these copper-aluminium alloys do not present a very definite yield point. The possession of a very definite yield point appears to be almost peculiar to steels, but all these points in the tables were determined by a pair of dividers in the ordinary way. The elastic limit of these alloys, as determined by Ewing's extensometer, is only about 10 to 13 tons per square inch. The alloy which was reported by German experts to have fallen to pieces was a heavy alloy. I think in getting a specification out for aluminium one should insist on having the aluminium as pure as possible, and I would like to see the limit of iron and silicon put at 0.5 per cent.; that is, the silicon, I should say, about 0.2 and the iron limited to 0.3. (MR. PARKER: They would want a big price for it.) Mr. Buchanan asked how I would suggest the preparation of aluminium alloys with chromium and other very high melting-point metals. I would suggest first preparing an alloy containing a fairly high percentage of chromium. I do not expect that it would be necessary to add very much chromium to get the maximum effect. The method would be to prepare first a fairly rich chromium alloy and to use that as the starting point. Mr. Coe asked as to the amount of silicon which gets into these alloys. I, myself, think that by using Salamander crucibles, and taking ordinary precautions, practically no silicon would pass into the alloy. (Applause.)

On the motion of the PRESIDENT, a very hearty vote of thanks was given to Mr. Lantsberry for his Paper and his explanations.

Stiffening Cores in Sand Moulds.

By Walter J. May.

In very many cases cores are too thin or slender to stand against the pressure of the molten metal unless they are in some way reinforced, and in doing this it is necessary to consider the necessity of removing the core from the casting. It would be easy enough to make cores for any purpose if they had to remain in the casting, as then methods could be adopted which are not otherwise applicable; but when we remember that a core must usually be, to some extent, compressible, while after the casting has cooled it must be sufficiently friable to be readily removed, and that it must also remain in its place in the molten metal in such a way that the space left in the casting is where it is required, some of the difficulties of the core-maker will be appreciated. Taking, for example, a steam passage core, such as roughly shown in section in Fig. 1, and assuming that this core is 3 in. wide, 10 in. long, and a bare ¼ in. thick, it will be readily conceded that if made in sand alone, without some form of reinforcement, it would not stand against the pressure of the metal; also, from its position it must not burn hard or be otherwise irremovable. Possibly some kind of glue or gum could be devised to stand the heat long enough to hold a loose sand core together, but in such case there is always a serious risk of the stuff not being properly used, and in such case the casting would be spoiled. Wire frames, as

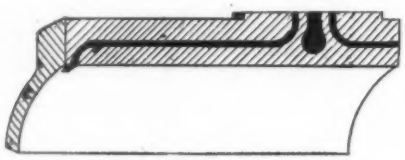


FIG. 1.

a rule, are therefore used, because they do not necessitate any great technical skill in manipulation, and also because they are easy to make and handle.

Fairly large thin flat cores are also difficult to keep stiff unless they stand on end in the mould, and here wiring becomes very necessary. Necessarily such cores would have wide prints arranged on the patterns, because the better they are supported by the mould, the stiffer they become within reasonable limits, but in most cases the use of wires to give tensile strength is generally desirable. Take, for instance, a thin flat core such as would be used in work like that shown in Fig. 2, and which could not be supported by nails owing to their showing up in the casting, and see how many would be broken if they were only, perhaps, a quarter-inch thick, unless they were wired. The thin core is shown in outline at B, with an inch allowed for bedding into the mould itself, but if anyone cared to work out the pressure arising from the metal, they would probably be surprised.

A small round or rectangular core of any length passing through a body of metal is very troublesome to keep straight, and where it is not possible to hold it down with wires or nails used as outside supports, and where the core cannot be arranged otherwise than horizontally, reinforcement out of all proportion to the size of the core becomes necessary, and as the core cannot be struck up in loam on a banded barrel or rod the matter often becomes rather a difficult one. Of course, when surrounded by molten metal there is less strain, although owing to its smaller specific gravity the material of which

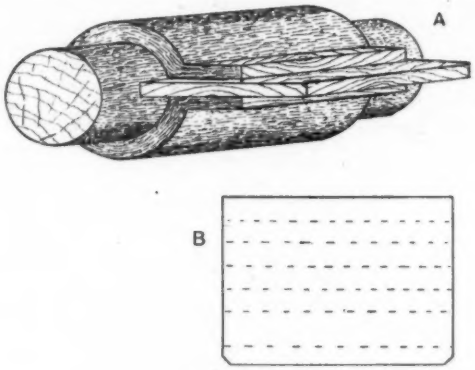


FIG. 2.

cores are made naturally endeavours to rise to the surface of the metal, and if not sufficiently held by the mould, owing to the shortness of the prints on the pattern, very often cores do get loose and spoil castings.

It being always desirable that with iron any surfaces to be machined should be cast downwards, the cores for the slots for the holding-down bolts have to be fastened to the bottom of the mould, and unless care is taken these cores cause much trouble.

FIG. 3.

Usually the better plan is to use a thin plate through their length, and into this have wires fastened, as shown in Fig. 3. The wires have nuts on them, and are passed through the sand, and a rather large washer being put over the ends, they are screwed tightly to the bottom of the mould by means of the nuts. The whole thing is cheaply made, and with

the aid of a punch and roughly-made screw plate the wires and strips can be easily produced.

The general methods of reinforcing cores are shown in Fig. 4, wires of different sizes being used according to the diameter of the cores, and the number of wires used for reinforcement being variable according to the ideas of those having the supervision of the work, both round and square wires or rods being used, as found most convenient. It is, however, usual to have the wires of sizes varying by sixteenths of an inch in thickness, though for some purposes wires of less than one-sixteenth of an inch diameter are needed. A cluster of wires in a core, as shown in Fig. 4, will have a much greater stiffening effect than if they were dealt with individually, free from the casing of sand, but necessarily the

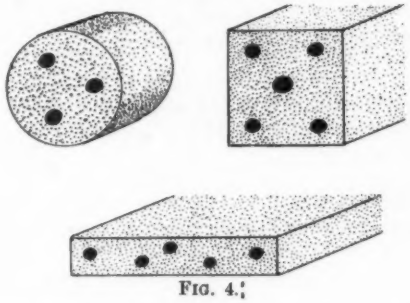


FIG. 4.

greater the cross area of the wire the greater the resistance to bending. The use of specially drawn wires or rods can scarcely be expected owing to their cost, but a point to remember is that round and square rods do not offer the greatest resistance to bending in proportion to their weight and solid content. Of course, if job lots of cruciform wire or small rod can be picked up cheaply there is nothing to be said against this being done, or if small tubing can be had at wire price it will be found very handy for many jobs, but chances of this kind do not often occur.

For the reinforcement of straight cores hard wires are best, provided they are made quite straight before insertion, but for curved or bent cores fairly soft wires should be used, while in the case of steam passage cores and the like sort of thing where difficulty of extraction is a likely occurrence, well-annealed wire is a necessity, or trouble is almost certain to ensue. Plain wire only is needed, but in

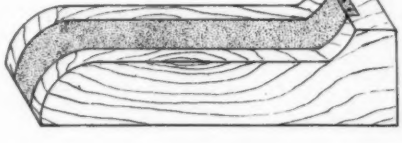


FIG. 5.

cases where particularly good adherence of the core body is needed, the wires should be slightly rusted by damping with a solution of sal-ammoniac, and after this they should be dipped in clay wash and allowed to become nearly dry before being placed in the cores.

In Fig. 5, the method of making the core indicated in Fig. 1 is shown, and in Fig. 6 a section of the core and box is given, no top part being necessary. The reinforcing wires are bedded in as shown, together with wax-wire for producing the vents, and the stout wire is laced together with some fine wire to assist the sand in resisting the upward pressure of the metal in casting. These enclosed cores must be sound, as a matter of course, and in addition they should be well coated with a wash of plumbago, but these are details which every core-maker should know, even if he does not carry them out.

Where the working can be depended on, the core mass should be made with a non-aluminous sand, held together with some binder that will either burn out by lengthy exposure to the molten metal, become reduced to friability by heat, or which will soften with water sufficiently to render the removal of the core mass and the reinforcing wires a comparatively easy matter. All enclosed cores should be coated with plumbago to ensure a smooth skin to the metal surrounding the cores, but where the openings left by the cores are to be machined it is usually the better plan to use a charcoal blacking for coating the cores, as this is better for machine work, the tools usually cutting better on charcoal than on plumbago facing. Sands that burn into the metal, or which harden so much as to be difficult to remove, however hard and strong they may be, are not fit for making cores, and when reinforced are too troublesome for any kind of work inside castings, although they make very good dry sand moulds for use outside the molten metal.

Where cores are struck up on bars or barrels for use in pipe-making and other long work, it is necessary that the bar or barrel be stiff enough to prevent the core from bending or "springing," when the castings are made horizontally, for when this occurs the resulting walls of the casting are of un-

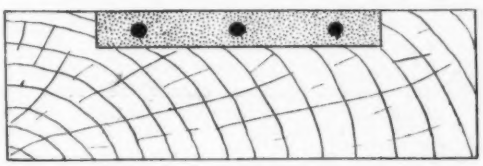


FIG. 6.

equal thickness. Where there is sufficient room the core barrels are better if cast, as they are then much stiffer than wrought tubing, but it must always be arranged in addition that the ends are sufficiently supported by the mould, or the gain in stiffness will be considerably minimised. Pipes and similar hollow castings made on end are not so liable to be unequal in thickness, as the pressure on the cores is then practically equal all round.

Taken as a whole, it is better to have the cores made of sufficient stiffness where possible, so that there is no necessity to support them through the body of the metal, because in the case where nails or other supports are used, there is always some risk of holes or porosity occurring, and where work has to be machined, faulty spots are likely to show up. In some classes of iron there is also the chance that the metal will chill round nails or similar supports, and where these hard places occur in machined work, the remarks of the machine operators are usually such as are worth avoiding, especially if the men are on piecework or their speed is closely checked.

MESSRS. GILL & CHAVIARA, consulting engineers, Scottish Provident Buildings, 25, Castle Street, Liverpool, have been appointed by Messrs. Marks & Clerk, chartered patent agents, of London, Manchester and Birmingham, as their representatives for Liverpool and district.

A Quick Method of Moulding Small Flange or Groove Pulleys.

By R. C.

There are few jobs in the foundry that lend themselves to so many different methods of moulding as do small flange and groove pulleys, and a different system could be found in nearly every other shop. Although the writer has seen them made in a variety of ways both in this and other countries he has not seen any method to compare with the one here described, either for accuracy or quick production. Fig. 1 shows an ordinary double flange pulley that in most cases would be moulded with two joints and with the bottom flange loose. Fig. 2 shows the same pulley mounted on a shaft and ready for moulding in the method about to be described. All that is required is to put on the moulding box, ram in the sand, give the plate a few light taps with a rammer or mallet (the plate should not be rapped sideways but on top) turn the lever and the patterns are revolved through the stripping plate and the mould is made. Exactly the same operation is followed to make the top halves, only with a runner stick rammed up, of course. If great care has been taken in making the plate and mounting the patterns, perfect castings will result, and forty pulleys an hour can be made by a boy or machine-moulder. Figs. 3 and 4 need no explanation and clearly show the whole thing. If the pulleys are to be cored out the shaft can be made the size of the core print and used for that purpose.

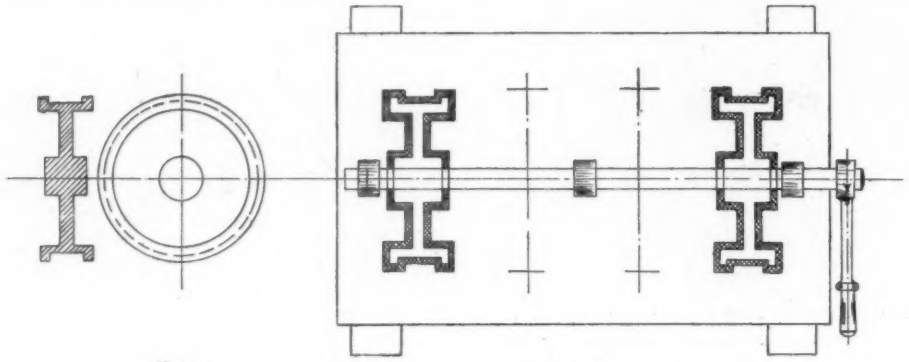


FIG. 1. FIG. 2.

The writer will now try to describe what in his opinion is the best method of making the tackle for this work. First, make the number of half-patterns that are required to fill the box, with a small machining allowance all over, then have them machined on the flat faces so as to form an exact half, then pinned together and turned up true in the lathe. The pattern for the stripping plate should be very carefully made, and the spaces for the pulley patterns

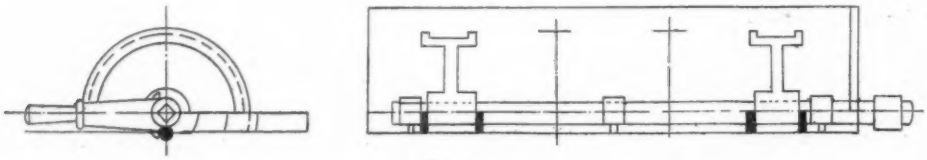


FIG. 3.

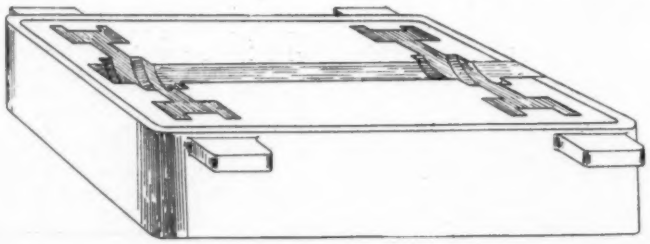


FIG. 4.

very accurately divided and left rather larger than the pattern, allowing for about ½ inch of white metal. Some provision should be made by the moulder when making the stripping plate to carry the white metal. This can be done by leaving a few small nails projecting into the space. When cast the plate should be planed on both sides and a small groove planed in to carry the shaft. All is now ready for the tool fitter to mount the half-patterns on the shaft and fit the same on to the stripping plate, securing it in position by means of small brackets attached to the edge of the plate. It will be observed that one set of half-patterns and one stripping plate are to do for both top and bottom half of mould, consequently the tool fitter must see that they are mounted an exact distance from the centre, also from each other. This done, the plate is ready to be returned to the moulder to have the white metal poured round the patterns, which should be on the underneath side of the plate, when this is done so that the metal is exactly the same radius the pulleys will traverse when drawn through the stripping plate.

In conclusion it might be said that the initial outlay for this method is somewhat expensive, but if there are many to be made it will soon pay for itself many times over and give better castings than can be made in any other way.

Imperfect Castings.

Lecture before Sheffield Foundrymen.

By S. G. Smith.

There was a large attendance at a meeting of members of the Sheffield Branch of the British Foundrymen's Association, held on Saturday evening, April 22. The special subject for consideration was "Imperfect Castings" and a Paper on this subject was read by Mr. S. G. Smith, of Chesterfield. Mr. Percy Longmuir, B.Met., President of the Branch, was in the chair.

Mr. S. G. Smith, in his Paper, said that while there was a cause for everything, the cause of many imperfect castings had not been discovered. The fact was that the foundry department of an engineering plant was the least under control, because foundry work was very often more or less in the research stage. Many castings made to-day were more complicated and difficult to mould, and the stresses and exacting tests were more severe than formerly. These matters were forced upon the foundry, to keep in line with advanced engineering projects, which sometimes gave rise to difficulties in the foundry. Ancient and modern art were totally different regarding purpose, cost, labour and time. Without enlarging upon the commoner forms of waster castings, but at the same time without belittling them, he went on to speak of castings that revealed faults in the machine shop and testing house. It was, he said, not always easy to fix upon the real cause of the defects disclosed, but there must be a cause, and the question of whether it could be obviated or not involved more or less metallurgy. If a casting had been rejected on account of hardness, either the grade or analysis had been at fault, or the cupola conditions had been very unfavourable. It was possible to spoil a good grade of iron by the addition of unsuitable scrap. It was also possible to improve an inferior grade of iron by using a good quality of scrap. If the iron had not been at fault, they must look to the melting conditions, which, if not favourable, would upset any mixture of iron, regardless of its suitability and quality when charged in the cupola. Improper control of the cupola would alter any grade or quality of iron between the charging door and the tapping hole. Draw places, sponginess, and shrinkage holes were defects that might to some extent be avoided by methods of moulding, casting, and feeding, but the metallurgical aspect was the most important. If they could procure an iron for foundry purposes which would not be subject to such occurrences, and could always be relied upon to give a uniform test, they would enter a long-sought Paradise, but that millennium would not be realised just yet. It had been established that grey iron expanded on the point of and after solidification, but in heavy sections or bodies of iron this would be difficult to determine, except locally, because, while the outside walls were frozen and set, the inside was in a semi-fluid and pasty condition. To a certain extent in practice they found that the iron in the liquid state was expanded in proportion to the heat it contained. The higher the temperature of the iron the greater would the expansion be, and probably this could be carried on until the gaseous or volatile state was reached, providing the temperature could be raised sufficiently high. Consequently, the higher the temperature when the casting was poured, the greater would be the shrinkage during cooling of the heavy parts. The shrinkage or draw holes were more pronounced in the thick sections of the casting, if in close proximity to a thin section. Undoubtedly this was due not only to the loss or evolution of heat, but also to the phenomenon of molecular action and attraction. When a certain point of temperature was reached there was a closing or drawing together of molecules to those parts of the casting which were cooling first, leaving draw places, shrinkage holes, and sponginess in the part which acted as a feeder to the surrounding parts, owing to its being longest in the liquid state, and where it could suck nothing, but had been sucked and drawn from. This would result in leaving an irregular, porous hollow in the casting, which might be expressed as liquid shrinkage or molecular attraction. But the closing of the molecules and the developing crystalline structure only commenced when the solidifying and expansion temperature was passed. Then the crushing and packing together of the atoms or molecules had only begun, because contraction did not commence until the parts solidified, which might be at different times in the same casting. Hence the possibility of internal and external stresses, with an irregular casting, from unequal cooling. Probably the extent of power exerted during the period of contraction would never be measured. When they considered that a tenth, an eighth, or a quarter of an inch, more or less, according to the quality and thickness of the iron, contraction per foot took place, they could only imagine what a compressive power there must be.

Mr. Smith went on to give a number of examples, illustrated by diagrams. He pointed out that in all

cases of vertically poured flanged castings, care must be taken to guard against the possibility of the upper surface of the flange top showing dirt, which was due to erosion, dust, and oxidation of the iron during the pouring. Some of this must necessarily flow into the top flange and remain there unless provision was made before or after pouring to get rid of it. Apart from this, vertically poured castings were decidedly superior, and the method should be recommended. To favour a solid flange, free from drawn places, a fairly reliable rule for use at the bottom of the feeding head was as follows:—Add the thickness of the flange, including the machinery allowance, to the thickness of the body of the casting, two-thirds of which, plus ¼ in. gave the thickness of the feeding head at the root. Another rule was that the head at bottom should be ¼ in. thicker than the thickness of the flange and increasing in area to the top. The depth of head should be according to length and thickness of the casting, and to some extent the quality of the iron.

Mr. Smith referred to the several theories as to the cause of globules of iron, shot, and shot cavities. The matter at present was more or less in the research stage. If any serious trouble was experienced from the presence of these undesirable objects, he would suggest, when practicable, a softer grade of iron, pouring at a higher temperature, and attention to the strength and porosity of the loam or sand.

He had frequently observed with grades of iron in daily practice—a No. 4, with an approximate analysis of combined carbon 0.65, graphitic carbon 2.5, silicon 2.0, manganese 0.5, phosphorus 1.25 per cent.—that the nearer they approached a mottled or white iron the more did the sinkage increase. On the other hand, between an open No. 4 and a close No. 3 the sinkage would be much the same, but approaching a No. 2 there would be a perceptible increase in sinkage, and passing to a No. 1, which might contain between 3 and 4 per cent. silicon, and the limit of saturation of carbon, the liquid shrinkage would still further increase. These observations were made without any special consideration of temperature, but the higher the temperature the greater would be the sinkage in every case. He was not now referring to special irons.

Regarding the variation in liquid shrinkage, it was possibly due to and depended upon the composition of the iron and rate of cooling in relation to section. Composition would, to some extent, regulate cooling and segregation. Of course, quite different results might be obtained by rapid or prolonged cooling, but he was now speaking of normal cooling. It seemed to follow that a No. 1 iron, owing to high silicon and carbon, both of which would retard cooling, would probably promote the graphitic state. In a No. 4 iron segregation would not be so advanced, by reason that the silicon, and probably the carbon, would not be so high, consequently a more uniform matrix and fracture, which was due to quicker cooling. In other words, the iron and metalloids were more uniform. For similar reasons, a No. 4 iron would have a higher melting point than a white iron. The silicon would be low, the sulphur high, and nearly the whole of the carbon would be in combination with the iron.

The PRESIDENT remarked that no man, particularly a man who had had large experience in a foundry, would admit that a waster was a disgrace. In every business wasters were made, and wasters only became a disgrace when the lessons they should teach were not learnt. No better method of research could be found if they only profited by the mistakes which were made. Each waster meant a discovery, and if this was taken advantage of then a waster became a source of good and not of harm. People who never made mistakes, and never made wasters, were not usually very useful. Mr. Smith had referred to molecular action. He had long thought that before they could get down to molecules and atoms they must settle the crystals, and their knowledge of crystalline cohesion was certainly not very great at present. In reference to shrinkage, Mr. Smith appeared to accuse the metallurgist of having done no work. (MR. SMITH: No). Mr. Wrightson, 15 or 16 years ago, was experimenting in a foundry on the North-East Coast, and he did a lot of extremely valuable work in this direction, and a good summary of his work was to be found in either the first or second Alloys Research Report.

One MEMBER of the Branch recommended the more frequent use of a spiral runner in foundry work. Better results could be obtained; he certainly did not believe in square runners.

MR. W. H. HATFIELD said he would own up. They occasionally would have wasters at his place. (Laughter.) Mr. Smith had described two kinds of blow-holes. Most of these, in his opinion, were due to trapped air. The lecturer spoke of iron by numbers. That would not do. It would be much better to take the analyses of the irons. Turning to defective castings he remarked that they had a number of men at his works who practically never produced a defective casting But some men were not so skilled as others in casting, and they, of course, produced more. They came finally in this matter to the moulder. Almost everything depended on him, on the care and skill he put into his work. (Hear, hear.)

One SPEAKER said he went by numbers in dealing with his iron.

MR. HATFIELD: Don't you find some irregularity in quality?

The SPEAKER: If we do we get on to the people who supply the iron. (Laughter.)

Another SPEAKER believed there was a movement on foot to try and persuade ironfounders to go more into the chemical composition of irons.

MR. SMITH, replying to the discussion, did not accuse their metallurgical friends of not dealing with the question of shrinkage. He knew they had done valuable work. But many years of practical experience only could enable them to deal with the actual difficulties which occurred. The Paper he had read was founded on his own experience, and that was the best test of what iron would do, and what difficulties arose in the foundry. (Hear, hear.) Speaking of runners—he had used all kinds of runners. He had run in at the top, bottom and middle, and used square, round and spiral. The great point was to use that runner which was best suited to the work they were doing. A spiral runner was best in some cases, but in many cases it was not necessary. He knew he should be pulled up on the question of iron numbers; it was unscientific to use numbers. He had always associated a certain analysis with a certain number, and if that was not right it ought to be. Numbers should certainly be some guide to the foundryman. (Hear, hear.) He was asked whether he thought speed had anything to do with wasters. It might have in some cases. Of course, they did not always get much time to think, and the pace they had to go at took all the thinking out of them. But as a rule, speed should not make wasters. The foreman was a fool who would so rush a man on a job of any importance that there was a probability of him getting a waster. The man's time, or the money it represented, was nothing compared to the loss which would come with a waster in such a case. (Hear, hear.)

Hearty thanks were accorded to Mr. Smith for his Paper.

Business Methods for the Ironfounder.

Manufacturing and Trading Accounts: Arrangement of the Accounts.

By Percival P. Richards, A.C.A.

The object of annual accounts is fourfold; firstly, to show what profit has been made; secondly, to show *how* that profit has been made; thirdly, to provide a basis for the next year's costings; and fourthly, to provide figures and information for use in the next year in guiding the policy of the management. Any set of accounts which does not fulfil all these requirements is defective and should be amended.

It is, unfortunately, a fact that the accounts of the average manufacturer (including those of the ironfounder) fall far short of these requirements, and provided they show the profit made and a statement of Assets and Liabilities, the form is treated as a matter of little moment. It does not follow that the form of the accounts should be a voluminous one; this should be avoided, the arrangement being such as to give a maximum amount of information in a minimum space. In order to get this, a suitable arrangement of books is necessary, but for the moment we are only concerned with the accounts themselves.

The necessary sections of the annual accounts are:—

(1). A Balance Sheet disclosing the assets and liabilities.

(2) A Manufacturing Account for each separate department of the business, showing the gross manufacturing profit earned in each department.

(3) A General Manufacturing Account, being a summary of the above Departmental Manufacturing Accounts and showing the total gross manufacturing profit earned; this figure being carried to the credit of—

(4) A General Trading Account of the whole business, showing all the trading expenses properly classified, and the net trading profit earned, which in turn is carried to the credit of—

(5) A Profit and Loss Account, to which is charged directors' fees, income tax, etc., the balance shown being the amount available for dividends, or for sharing between the partners.

The detailed form of the Balance Sheet depends on the exact nature of each business to which it is adapted, but generally speaking, the items should be set out in a fair amount of detail, and in the case of "fixed" assets, such as freeholds, leaseholds and plant, additions and deductions during the year, and depreciation written off should be clearly shown. Grouping of assets should be avoided as much as possible. These remarks, of course, need not apply to the published accounts of companies, as it is entirely a question of policy as to what information shall be disclosed to outsiders.

The next accounts to be considered are the departmental manufacturing accounts, and these are of the greatest importance, their object being to disclose the actual gross profit made on each of the different classes of castings made. For this purpose the business is divided into several departments, each department making castings of a certain class. The actual classification depends entirely on the nature of each individual business. The subject of departmental accounts is an important one and requires separate treatment in these pages at a later date. One of the most important advantages of departmental manufacturing accounts is that they disclose where the profit is made and where profit is lost, thus placing the management in a position of knowing which classes of casting to cultivate and which to drop, and also in cases of falling profits to be able to easily locate weaknesses and apply suitable remedies.

The form of the General Manufacturing Account—which is a summary of the departmental manufacturing accounts—recommended is as follows:—

General Manufacturing Account.

Debit Side.	£	£
(1) Stock of Finished Castings on hand at beginning of period.		
(2) Materials Used in Manufacture.		
(*a*) Cupola Materials.		
Hematite.		
Pig-iron.		
Scrap iron.		
Other metals.		
Coke.		
Limestone.		
(*b*) Moulding Materials.		
Green sand.		
Loam.		
Small coals.		
Plumbago.		
Etc.		
(*c*) Other Materials.		
Timber.		
Stores.		
Etc.		
(3) Wages Paid		
Patternmakers.		
Coremakers.		
Cleaning and Fettling.		
Breaking Metal and Cupola charging.		
Labourers.		
General Wages.		
Etc.		
Gross Manufacturing Profit Carried Forward.		
		£.

Credit Side.—	
(1) Sales less Returns.	
Deduct Carriage and Freight outwards.	
(2) Castings for own use.	
(3) Stock of Finished Castings at end of period.	
	£.

It should be noted that the Stocks shown include nothing but finished castings, and these should be entered at the cost price only, as shown by the cost cards in use.

It is a mistake to enter metals and materials *purchased* in this account; they should be converted into

materials used in each case by the following method, pig-iron being taken as an example:—

Pig-Iron.

	Tons.	£
Stock at commencement.		
Add Purchases during period.		
Deduct.		
Allowances.		
Stock at end of period		
Balance being amount used.		

The amount of iron purchased bears no relation to the castings sold, as large stocks may be bought and held for some time in view of a rise in market prices, such amounts appearing in the stock at the end of the year. The accounts should show the cost of each item incurred in making the castings sold, and in the case of pig-iron it is the value of the amount *used* which represents the actual cost incurred. This point is important in view of the use to be made of the figures in the accounts, as explained later. The same remark applies to all the charges under the heading of materials, the figures for all stocks on hand (except the finished castings) being thus absorbed in the manufacturing accounts, the weight and cost of each item being shown separately. Foremen's wages should be charged under each of the proper headings, the moulders' foreman being, for instance, included under moulders, and so on. General wages include storekeepers, engine men, engineers, yard men (not labourers), etc.

Carriage and freight outwards is deducted from the sales in order to show the value at the foundry, there being no profit on freight charged to customers.

The form of the trading account is as follows:—

Trading Account.

CREDIT SIDE.—

(1) Balance Gross Profit, brought from the Manufacturing Account.
(2) Discounts obtained (Cash discounts only).
(3) Any Sundry Receipts.

£.

DEBIT SIDE.—

(1) MANUFACTURING EXPENSES.—
Coal.
Power and Light.
Gas.
Water.
Repairs and Maintenance.
Salaries.
Carriage inwards.
Etc.

(1a) DESIGNING EXPENSES.—
Salaries, stationery and utensils.

(2) GENERAL EXPENSES.
Rent.
Rates and taxes.
Insurance.
Gas and Light.
Bank Charges.
Petty Cash.
Gifts and Subscriptions.

(3) OFFICE EXPENSES.
Salaries.
Printing and Stationery.
Postages and Telegrams
Incidentals.
Telephones.

DEBIT SIDE—(*cont.*)

(4) SELLING EXPENSES.
Salaries.
Commissions.
Travelling Expenses.
Incidentals.
Advertising.
Cost of Agencies or Branches.

(5) DISCOUNTS ALLOWED.

(6) PATENTS AND ROYALTIES.

(7) BAD DEBTS.

(8) DEPRECIATION.
Buildings.
Plant and Machinery.
Loose Tools.
Patterns.

Total Trading Expenses.

Balance. Net Profit on Trading carried to Profit and Loss Account.

£.

In this account each item of expense is properly classified under the appropriate heading, so that accurate costs may be obtained direct from the annual accounts and without the necessity of obtaining numerous figures from different sources and then using them as a basis for costings. The importance of this point cannot be emphasised too much, as the only costings figures which can be safely used are those based upon the accounts.

In preparing the trading account the total of salaries as shown by the private ledger is analysed under the following headings:—

(1) Manufacturing Salaries.
(2) Designing Salaries.
(3) Office Salaries.
(4) Selling Salaries
(5) General Salaries (if necessary.)

Under manufacturing salaries should be included the amounts paid to the works manager and his assistant, the chief engineer, sometimes a proportion of the managing director's salary, and any works clerks who spend the whole of their time in the foundry.

Foremen's wages should be charged to wages in the manufacturing account. Designing salaries include the head draughtsman and his assistants in the drawing office. Office salaries include the secretary, the accountant, the bookkeepers, general office staff and pay clerks, etc. Selling salaries include travellers and agencies. If any considerable item of expense is incurred in running, say, a London branch, the expenses should be shown under a separate heading on the trading account.

Gas, water and electric light used in the general offices and other buildings is separated from that used in the foundry and the shops, and charged separately under the heading of general expenses. As far as possible all expenses directly applicable to manufacturing should be charged under the heading of manufacturing expenses.

These manufacturing expenses are sometimes charged direct into the manufacturing account instead of into the trading account, but this is not desirable or advisable, for by so doing the real effect of the costs of materials and wages on the gross profit is often obscured.

The net profit shown on the trading account is carried to the credit of the profit and loss account, which is as follows:—

Profit and Loss Account.

DEBIT.

(1) Directors' Fees.
(2) Debenture Interest.
(3) Income Tax.
(4) Balance, being Net Divisible Profit.

£

CREDIT.

(1) Balance of Trading Profit.
(2) Rents Received.
(3) Transfer Fees.
(4) Income from Investments.

£

Having prepared the accounts and ascertained the profit available for division between the partners or shareholders, the question then arises what further information can be gleaned from the figures, and to what other uses can the figures be adapted? The consideration of this subject, however, will be reserved for another article.

Points in Favour of Machine-Made Cores.

By S. H. R.

The advantages associated with the use of a machine for making round cores are numerous. The cores can be readily stocked in all sizes, and if made in a suitable mixture will not perish or lose their toughness for several months. This in a jobbing foundry is a considerable advantage, as the foundry foreman often has a pulley or similar pattern brought to him about 4 o'clock and is expected to make two or more castings the same day. Frequently have the moulds been made and not cast, owing to the core lad not having the cores dry, or producing them when the iron is down and the cores still too hot to handle. It is difficult to keep a reliable stock of hand-made cores; if the core has an iron in it and is not the length required, it is generally broken by the moulder catching the iron with his saw or file.

Again, hand-made cores, if stocked, soon become nash and crumble up, unless kept in a stove all the time, and few foundries have accommodation in their stoves for a stock of cores. Machine-made cores, on the other hand, can be stacked one above the other in 2-foot lengths and kept anywhere handy in the foundry without deteriorating. A wooden rack with a separate compartment for each size of core, with the size of the core plainly marked on the front, is the most convenient means for storing them. The lad in charge of the core machine goes round the shop each morning, ascertains the length, number and size of cores required by the moulders, and delivers them by 9 o'clock.

These cores being waterproof, the moulder can core up as he goes along, and has not all his coring to do just before casting time. A machine-made core is always perfectly round, and when cast vertically is easily kept straight. The writer frequently casts ¾ in. diameter cores 15 in. or 16 in. long through the bosses of speed pulleys. If the core has to be cast horizontally, care must be taken to stiffen the core. There is always a considerable amount of sag in a machine core, and it is surprising how far a core will bend before it breaks. If the casting has not to be turned, the simplest and most convenient way of staying the core is by means of pipe nails or spikes. A more tedious method is to thread a square iron through the vent. This is fairly easily done, but care must be taken or the core will get broken. The vent hole being circular, there is plenty of room for the gases to escape round the square iron.

So true and clean can the holes be cast that only a very bare margin for machining is necessary. The mixture of sand and oil employed for such cores leaves the skin on the casting perfectly free from sand, in marked contrast to the old red sand cores, which were generally anything but round, and left a white, sandy skin on the casting, very injurious to drills or boring tools. Machine-made cores are very easily knocked out of a casting, a short spell in a rumbler almost invariably fetching them all out. The outlay on a core machine is not very heavy, £20 being generally sufficient to cover the whole expense, but from what the writer has seen of the average American machine, there is still room for improvement. There does not seem much attempt made to keep the sand out of the bearings, and as these are seldom a good fit the driving wheel and pinions soon become loose. Still, loose or tight, they do their work all right. There are a few obvious precautions to take. The machine must be thoroughly cleaned of sand immediately after use, and the tubes (or dies) and screws be kept bright.

The writer was once bothered considerably by the clogging of the machine near the end of the screw after a few feet of core had been made, and traced the source of the trouble to the use of a quantity of stale sand carelessly mixed with the new. Any sand left from the previous day may be used, but it must be carefully sieved and mixed with a quantity of new sand. It is always policy to use up all the sand mixed whilst it is fresh. The cores must be dried at a low temperature and left in the stove long enough to get the oil well out of them. When well dried, they are very hard and do not feel greasy. Odd and broken lengths of cores are collected, and after being ground up can be mixed with oil and used again. The all-important thing is to obtain a suitable mixture of sand, and this is not so readily done as one would gather from the circulars of machine manufacturers.

The sand should contain as little clay or binding material as possible, and it is much better to get a sea-beach sand and mix a little of the local sand with it. The writer has tried many binders, but found nothing so satisfactory as boiled linseed oil and core gum. The exact quantity to use depends, of course, upon the quality of sand, but by a few experiments with varying quantities of oil, a reliable mixture is soon obtained. The high price of linseed oil is a drawback to its use as a binder, but nothing else appears to be so satisfactory.

Cores over 1½ inches diameter are made much cheaper on the plunger type of core machine, in which the core is rammed up in a die by hand and is then forced out by a plunger. One inconvenience experienced in the introduction of a core machine is the lack of parting sand, owing to the disuse of red sand cores. The writer finds the dust from the rumbler mixed with a little burnt red sand a good substitute.

A core machine at first sight does not appear much of a money saver; the sand costs more, the screws wear out and have to be renewed, and a certain amount of supervision is necessary. On the other hand, there is a saving in labour, there are fewer wasters owing to badly jointed cores, and a reliable stock of cores is readily kept, so that indirectly it is a source of economy.

Foundry Practice.

Cleveland Institution of Engineers.

The last meeting of the Cleveland Institution of Engineers for the Session 1910-11 was held at Middlesbrough on Monday, April 10, when Mr. Thos. D. Wilson, of Middlesbrough, submitted a Paper, which was profusely illustrated, and of which the following is an abstract, on "Foundry Practice."

The author, in his Paper, said that the preparation of the sand for various classes of work was an important factor in the production of a clean and sound casting. The immense deposits of fine sand on the North-East Coast were of little use for foundry purposes, because of the absence of alumina and the spherical or pebbular form of the grains. Foundry sand must contain 4 to 16 per cent. of alumina or clay, and the grains of sand must be of angular form. With the smaller proportions of alumina the sand was suitable for light castings, such as kitchen utensils, fire ranges, baths, etc. In all cases with heavy work it was essential to use a stronger sand, *i.e.*, a sand containing a high quantity of alumina.

To-day the heavy "green sand" casting is not so much in evidence, owing to the more exacting demands of the engineer. The foundryman finds he has something to tackle which is more complex and difficult than anything he has accomplished in the past. In the earlier times complicated castings were made in loam moulds. Now that they are more complex, and in many cases very much heavier, dry sand is more practical, especially for marine, oil, gas, and other large engines and heavy machinery. Dry-sand castings, such as gas and water-pipes, also retorts, that were in common use in the earlier gasworks, were made in dry-sand moulds. The author's earliest experience of a heavy dry-sand marine casting was at the late Sir Charles Mark Palmer's foundry at Jarrow-on-Tyne forty or fifty years ago. This was a high-pressure cylinder for one of the British warships, and was probably the first attempt of the kind on the North-East Coast.

The drying of moulds of this description is of the greatest importance, and various systems and methods are adopted—open coke fires, hot air, and gas from producers. The last has not been in general use, except for core stoves and in dry-sand pipe foundries. The author believes that if it were adopted at a marine foundry it would prove economical, much cleaner, and more easily controlled. In the United States kerosene, or mineral oil, is extensively used.

Mechanical moulding has been largely adopted of late years, direct-power hydraulic machines being the most general. Compressed air is adopted at some foundries, but the former is preferable by reason of its economy in first cost and maintenance. In America machine moulding is far more in evidence than it is in this country. There is, however, no machine capable of doing all the operations of hand-moulding. The cost of pattern plates and stripping plates, the making of which requires a great amount of skill and time, has, no doubt, been one of the deterrents to the more general use of machines in the foundry.

With regard to mixing, he stated that there has been much talk and more writing about the mixing of metal by analysis and fracture for foundry purposes. Some go so far as almost to ignore the value of chemical science in this particular branch, while others say or imply that the metallurgist is the founder's base of success. In the former there is a lack of faith based probably on partial success without his aid. It is, again, most probable that the keynote of the success of the metallurgist lies in the fact that the work accomplished is of a very uniform nature, as in the case of foundries making car wheels (a class of castings made very largely in the United States), also chilled and grain roll foundries, and in many others where castings of a uniform class are made, and which must be kept up to a specific standard in quality and strength. In these special foundries they have a direct and definite line on which to work. Here the metallurgist is almost indispensable, as the physical and chemical tests must be adhered to, and uniformity in these cases is of great assistance to the regularity of working. The iron is classified, the cupola is worked daily under the same condition, the cupola man goes through the same daily routine, and a great measure of success is the result.

Now the problem on Tees-side is:—Can the founder by the aid of the metallurgist succeed in selecting and classifying metals suitable for the very varied class of castings that the district produces? The metallurgist says "Yes," and the author thinks he is right.

Dealing with mixing of metals, Mr. Wilson said that the metallurgist under ordinary conditions in the foundry was very heavily handicapped in his endeavours. He was right and his work was in the right direction, but the ordinary conditions under which he worked were not so favourable as they would be if re-melting of the metal were allowed. Mr. P. Munnoch in a Paper on "Pig-iron for Foundry Purposes," said "Iron for special castings is in some cases re-melted once or twice before casting," but thinks this is only necessary when a higher grade of iron than is required is being used; "re-melting may lower the grade by the loss of silicon and manganese and an increase of sulphur." Mr. Wilson's view was that the physical test was certainly not lessened by the re-melting. His experience was that it was stronger and closer-grained by the operation. Mr. J. F. P. Lewis, in a lecture to the Scottish Branch of the British Foundrymen's Association, claimed that better results could be gained by the use of known pig-iron. He was also opposed to mixing by analysis on a silicon basis, and said it was absolutely unscientific, the mixing of high- and low-silicon irons in the foundry being a fatal mistake; but Mr. Wilson contended that the mixing and then re-melting gave a decided advantage. One argument against re-melting was the loss of the elements silicon and manganese and the increase of sulphur. The amount of silicon lost was from 0.2 to 0.3 per cent., and manganese to approximately 0.1 per cent., the increase of sulphur depending principally on the quality of the coke used. This, some would say, involved expense in the consumption of fuel, and additional labour, but it would be counterbalanced by the full knowledge and security of what was being undertaken. The cost of re-melting should not exceed 7s. 6d. per ton in the finished casting. This, in comparison with the occasional loss of, say, a valuable marine cylinder or similar castings, after much expense had been incurred in machinery, should be an incentive to the adoption of the re-melting and mixing process. Now that the valuable assistance of the metallurgist in the foundry was forthcoming, it was the bounden duty of every engineer and foundry manager to assist him. There were metals mixed and put on the market suitable for most purposes, but at

prices quite prohibitive. To large engineering firms and iron-founders he would say, "Why not mix your iron on the lines which will guarantee you some prospect of success, and at the same time give your metallurgist a fair opportunity of proving his worth?"

The difficulties which the foundry manager had to meet in a general foundry where the work is of a varied class did not always depend upon the mixing of his metals. Bad castings were due to many other causes, and it was the lack of experience of his men which gave the foundry manager the bulk of his trouble.

Discussion.

Mr. J. E. Stead, F.R.S., remarked that he fully recognised the necessity for the foundry manager taking counsel with the metallurgist. They should work together hand in hand. The good old-fashioned iron-founder frequently did not like interference, but a metallurgist or chemist could be of great use in the foundry. As to re-melting the mixtures of iron used, Mr. Stead thought it was very desirable, but allowances would have to be made for the changes which were brought about by the re-melting. One could not get the same tests after as before re-melting.

Mr. H. B. Toy, of the Chilled Roll Company, Haverton Hill, remarked that Mr. Wilson in his Paper had stated that phosphorus varied in contents in different brands of pig-iron, but not to any large extent. He would like to know what the author considered a large percentage. He found a very great difference in phosphorus content between ordinary Cleveland and hematite pig-iron. He could not purchase pig-iron of a definite chemical composition, and it was absolutely necessary for him to have the assistance of a metallurgist. They could not trust to selecting iron by fracture; it must be selected by analysis for their work.

Mr. Walter Crook, of the Shotton Steel Works, Flintshire, said Mr. Wilson had left out one important method of making castings. He had enumerated three—the green sand, dry sand, and loam, but he had given a wide berth to the manufacture of chilled castings. He did refer to them, but only in a mild sort of way. He (the speaker) believed there were no papers or records in connection with the Cleveland Institution that told anything about chilled castings, the iron to be used, and how the process was to be carried out.

[It was here stated that Mr. Toy had promised to read a Paper on this subject before the Institution next session.]

Mr. Fredk. P. Wilson, Tees Ironworks, Middlesbrough, said that where there was a good deal of repetition work, such as in the production of chairs and pipes, the adoption of mechanical moulding would be an advantage.

Mr. Stonewall Jackson, of Richardsons, Westgarth & Company, Middlesbrough, said he might mention that at that firm's works they had for some time being employing crude oil for drying moulds; it had been a great success, and there was a considerable reduction in cost. The time taken in drying by the aid of oil was much less than by coke fires. Mr. Wilson agreed as to the necessity for the employment of a metallurgist in an iron foundry. He was an advantage in many respects, particularly when as an engineer one sometimes had to take iron as a matter of policy which was not all one would like. With a metallurgist one could profitably use such pig-iron. The metallurgist would advise as to the proper mixtures.

Mr. D. B. Holt, of Greenwood & Batley's, Leeds, maintained as an engineer that the foundry question was a most important one, and had been neglected too much in the past. It was, however, now better understood. Machine moulding had come to stay, but they would not be able to dispense with the skilled moulder.

Mr Wilson undertook to reply in writing to the criticisms on his Paper, and was thanked for his contribution.

Fluxes and Slag.

Before the Middlesbrough and District Association of Foremen-Engineers and Chief Draughtsmen, Mr. Sidney G. Smith (Chesterfield) recently read a Paper on the subject of "Fluxes and Slags," an abstract of which is given herewith:—

In cupola practice a flux is added and mixed with the charges of iron and coke in the form of limestone or fluorspar, sometimes both, to assist the melting conditions by forming a fusible free-flowing slag, by combining in liquid form the ash of the coke, silica sand adhering to the pig and scrap, and any other foreign matter that enters the cupola. Fluxing is a necessary function, and assists in obtaining a clean melted iron and a clean cupola.

Some of the changes and combinations that occur are as follows:—

When the limestone (calcium carbonate) reaches the hot part of the cupola, quantities of carbonic acid are evolved, to the accompaniment of popping and cracking of the pieces, resulting in lime, which remains as such until the temperature of about 1,800 degrees F. is reached, when it combines with the silica and other foreign matter to form the slag.

Pure limestone contains 56 per cent. of lime and 44 per cent. of carbon dioxide gas. Fluorspar (calcium fluoride) is regarded as a more effective flux than limestone, as it is claimed that its use is attended by a large reduction of sulphur in the iron. It acts as a flux on silicates in two ways—(1) By combining with the silicate to form a fusible compound; (2) by decomposing the silicate forming gaseous silicon fluoride.

Fluorspar contains about 10 per cent. more lime-producing calcium than limestone, and while 44 per cent. of limestone is volatilised and passes up the stick of the cupola, the whole of the fluorspar is utilised, owing to its non-decomposition until the fusion zone is reached, where its function is performed in producing a very fluid and thin slag. In practice, probably the most satisfactory flux is a mixture of both the foregoing.

If the fluxing material is limestone, it is soon decomposed by the heating action of the ascending gases. The carbon-dioxide (CO_2) escapes through the stack, while the descending lime combines with the silica to form a silicate of lime. There are a number of chemical combinations which are taking place in this case. The first stage is that limestone is reduced to lime and carbonic acid is driven off. In the second stage, lime combines with silica, forming lime silicate. This is actually the first combination which takes place, on account of lime being such a strong basic substance and having a great affinity for silica. No other combina-

tions of importance will take place at the moment as long as silica and lime are present in proper proportions. In the third stage, iron oxide combines with silica, forming ferrous silicate. This combination takes place either through not providing sufficient lime to combine with the silica, or through an excessive oxidation of iron to iron oxide, owing to the metal being too much exposed to the blast. In the final stage, lime combines with iron sulphide, forming calcium sulphide and ferrous oxide. Should there be a slight excess of lime still left uncombined with silica, the former will take up the sulphur, and it may be possible to obtain an iron almost free from sulphur, but the amount of limestone necessary to keep the slag of a basic character would be too large in comparison with the amount of coke used.

The analysis of a suitable cupola limestone would be as follows:—Lime, 50 to 53 per cent.; carbon dioxide, 42 to 45 per cent.; silica, 0.25 to 1 per cent.; with very small percentages of hydrogen, phosphoric acid, and ferrous oxide.

With cupolas that are running daily on one class of iron the fluidity or sluggishness, colour and general appearance of the slag should be some indication regarding the condition, whether favourable or otherwise, during melting. Slags vary in colour from grey to black, and may be called silicates and aluminates, and are the results of union or combination of silica, alumina, lime, iron, etc., as silicates. The condition of the slag is affected by the coke, blast, quality and quantity of the flux, but if these are favourable a medium-colour free-flowing slag indicates a sufficiency of limestone, and a desirable absence of abnormal ferrous oxide. A sluggish, thick-flowing, dull-black slag indicates a scouring condition, and will be high in iron oxide, which may arise from various causes.

To briefly summarise the practical conclusion that may be drawn for ideal cupola working conditions:—

The tuyere area should supply sufficient air containing the requisite amount of oxygen to produce the carbon dioxide state, bearing in mind that volume in cupola work is of more importance than pressure.

The quality of coke and flux should be within certain specifications.

The iron, coke, and flux should be measured or weighed, and uniformly charged.

The amount of flux necessary should be ascertained by experiment, owing to the varying conditions of the iron scrap as regards cleanliness.

The slag should be occasionally analysed, as a safeguard against an abnormal iron content.

If the blast is not sufficient, extra coke will not make any improvement, but rather the opposite: on the other hand, if the blast is more than sufficient there will be a waste of energy, and possibly a harmful oxidising influence, which will be the case if free oxygen exists in the upper part of the cupola, as can be ascertained by an analysis of the gases.

An insufficient amount of flux or coke will favour a dirty iron and cupola, and an over-sufficient amount of either will be no benefit, but will be costly.

The preparation and general manipulation of the cupola by the melter-in-charge is a factor that must not at any time be overlooked.

Discussion.

Among those who took part in the discussion were Mr. T. D. Wilson (of Messrs. Wilson, Copley & Company, Middlesbrough), Mr. R. J. Worth (of Messrs. Worth, Mackenzie & Company, Limited, Stockton-on-Tees), and Mr. E. Lansdale, (Cochrane & Company, Limited, Middlesbrough). The discussion broadened beyond the scope of the Paper, and dealt chiefly with the position, area, and number of tuyeres suitable for different size cupolas, blast pressure, quantity and moisture, density of the coke, methods of charging etc.

Mr. Smith in his reply recommended for cupolas 40 in. diameter, 5 round tuyeres of 4 in. diameter; for cupolas from 40 to 56 in. diameter 7 rectangular tuyeres, 7 in. by 4 in.; for cupolas from 56 in. to 72 in. diameter 9 tuyeres, 9 in. by 4 in., semi-circular ends, the position being vertical; one row of tuyeres in each case. The pressure of blast should not exceed 6 ozs. in a cupola 24 in. diameter; from 24 in. to 48 in. diameter, 8 ozs.; from 48 in. to 60 in. diameter, 10 ozs.; from 60 in. to 72 in. diameter, 12 ozs.

The weight of charge for cupola	24	in. dia.	should be	6 cwts.
,,	,,	36	,,	12 ,,
,,	,,	48	,,	20 ,,
,,	,,	60	,,	25 ,,
,,	,,	72	,,	30 ,,

The quantity of good cupola coke per ton of ordinary Cleveland iron should be about 1½ cwts., or equal to that in measure; for special irons low in metaloids, about 2 cwts., which may vary with circumstances and conditions. Coke containing a high amount of moisture has been proved by some experiments to be economical without any bad effect.

Hoists for Foundries.

In a Paper read by Mr. H. Prakken before the Chicago Foundry Foremen's Association, the author observed that the average power required by four 5-ton air hoists having a hoisting speed of 15 ft. per minute was 39.7 h.p., as compared with 9 h.p. for an electric hoist of the same capacity and speed. The power for the air hoists represents the amount which has to be generated at the compressor to compensate for the line loss and leakage, while the electrical horsepower is that required at the hoist. In an air installation where many tools and hoists are in operation the pressure varies at different parts of the line much more than it would when using an electrical supply. This variation results at times in a sudden raising of the load where the latter is balanced on a cylinder hoist, causing damage to the load where it is a mould in a foundry. As holding the load at any point by the electric hoist is not accomplished by a balance of pressure, or by a stroke, the advantage of the latter is obvious where delicate moulds or hot metal are handled.

The selection and control of hoists in foundries is a subject offering almost as many diversities as there are different shops. The variety of hoists for this work has finally narrowed down to the air and the electric types except where the hydraulic hoist may be installed for very heavy work. The air hoist when in proper working order is ideal for foundry use as far as speed control is concerned, with a range from a hardly perceptible speed to one as rapid as desired. The prime result to be attained in a foundry control is slow speed at all loads, high speed being only of secondary importance except in special cases where the class of work may demand a very high ultimate speed, as well as a very slow initial one, and, generally speaking, the former should decrease as the capacity of the hoist increases. For instance, a 1-ton hoist might have an ultimate speed at full load of 20 ft. per minute, while a 1½-ton hoist need not exceed 15 ft. per minute, and a 2-ton hoist might be as slow as 10 ft. per minute, without in any way affecting the output of the gang working under it, as the higher capacity hoist usually indicates larger and more difficult work. Very good control can be obtained from one-quarter to full load, which will eliminate the necessity of the moulder trying for a notch on the controller which will lift at a slow speed any load that he may have on the hook. The proper foundry control should permit the lifting of any load up to and including full load at a desirably slow speed on the first notch of the controller.

Modern Foundry Practice; Its Opportunities and Demands.*

By Thos. D. West.

This subject may be said to possess two sides, one the commercial and the other the educational, involving more directly the practical man. Some 30 years back little was known of the latter in the sense of what is now considered the technical part of the founder's art. More plainly speaking, this implies an understanding of the principles involved in the various manipulations of moulding and melting, as well as having a fair knowledge of drawing, chemistry and metallurgy.

It can be truly said that almost every manipulation in founding involves some principle that is essential to be understood in order to avoid difficulties and ill success in making castings, and no one stands in more need of this education than the overseer or shop manager. It is to be understood that reference to these officials implies those having direct charge of the producing departments, and not the heads of the financial, office or commercial end of the foundry business.

Value and Need of Masters in Founding.

The art of founding is insistent in its demands for intelligence, experience and skill. To be the master is not only to possess good intelligence and executive ability, but to be able to show the best experienced moulders how work should be done, by doing it yourself if necessary, in connection with possessing a technical knowledge of the principles involved in the work. A great demand exists for the creation of masters to fill coming needs. No mechanical vocation offers the vigorous master a more honourable and remunerative position than founding. The prominence of specialties and the unwillingness of youths to devote the time they should do amidst the dirt and smut of a foundry in order to rightly learn the trade, is now so prevalent, that the coming generation of founders will have few if any, if conditions are not changed, who could be justly called masters of the art.

A belief is held by some that the moulding machine will eventually dispense with the need of highly skilled moulders and founders. While the moulding machine is now greatly employed in foundries, there still exists an urgent demand for the all-round good moulder and expert founder, and such will always be the case as long as metal is needed for castings.

In speaking of the market for American castings, it may be mentioned that one notable difference in the character of American castings from that of English and German productions lies especially in the iron finished machinery of the former being of softer grades. This was due to the desire to save time in finishing, but strength was sacrificed to save labour. Criticisms on this practice have resulted in using harder and hence stronger iron in our export machinery.

Modern Specialties in Castings.

There are fully 50 prominent and distinct lines being now conducted as strict specialties, and indirectly many more demanding the entire attention and services of the best intelligence and skill that can be obtained. Like general work, the more experience one obtains with these problems in specialties, the better fitted he is to solve any coming later on. Risks are generally greater in the specialty shop than in general or jobbing shops. For instance, if something goes wrong to make a bad casting in a specialty shop, a good part of the whole day's output might have to be sent to the scrap yard.

While on this subject of strict specialties, it is to be understood that there are many of such that can tender excellent experience to assist the creation of good moulders, as well as affording conditions that will suffice to make good foremen, superintendents and managers for not only their own specialty but for a number of others.

A car wheel foundry illustrates the system and order that may be maintained in a strict specialty shop, and the chances there are for good profits, where methods, practices and management are such as to be a little ahead of the other fellow. Car wheels have to stand an inspection and tests, and in order to keep up the standard demanded, constant, sharp watching is required on the part of a foreman.

The straight floors in the modern car wheel foundry are considered an improvement that has considerable advantage over the circling floors so long in use by the wheel founders. Moulding machines have been tried for this work, but as far as can be learned they have not decreased the costs shown by hand methods. When it is known that one wheel moulder and a helper turn out daily from 22 to 25 wheels, weighing 650 and 750 lbs., the chances for great improvement by moulding machines in this line do not seem as favourable as in some other specialties.

The making of cast-iron water pipe is a speciality of considerable importance. Like most other prominent specialties it has made most rapid strides within the past five to 20 years in seeking and adopting shop improvements and labour, saving devices. These involve methods of conveying and mixing sands; machine and hydraulic ramming of the moulds; advantageous designs of flasks; continuous system of moulding, pouring and cleaning. The straight floor system is used by the new shops, and is found quite an improvement over the circling floor. The improvement with pipe moulding has been very effective in decreasing the hard physical labour formerly required. Common labour is trained to do nearly all the work. Few improvements have been so radical in any specialty as in pipe making. There are times when difficulties and losses may be encountered in this line as in others of founding, and experience is required to correct them.

The specialty of radiators is largely routine nowadays, moulding machines being chiefly employed. The making and holding of the core in position, to give a uniform solid thickness of about 5-32 of an inch of metal through the body of a casting is the chief difficulty encountered in this line. Few founders have been called upon to exhaust the resources of our core compound, oil or resin supplies more than those making radiators. This is owing to the cores being greatly made without rods, small outlet for the escape of gases and the desired easy removal of sand. The castings have to stand a hydrostatic pressure of 120 lbs. per square inch. It is all work which demands great precision in the making of patterns and core pans, and offers a field for systematic methods and adoption

* Abstracts from a lecture before the students of Carnegie Technical Schools and Foundrymen of Pittsburg.

of labour-saving devices that is unequalled by few specialties.

Foundry Equipment.

It will seem odd to many to hear it said that some still occupied in founding can remember the day when, if one were in need of any tools for the shop, he had to make them, or hunt up some one to do so on the jobbing plan. To-day there is a strong competition in supplying almost everything a foundry needs. Not only are the known needs supplied with attractive designs and prices, but seldom a week passes that we are not called upon to consider something new by congenial salesmen of firms who make a study of the founder's needs.

The introduction of moulding machines met with great opposition, but as determined men persisted, it gradually wore away and to-day wherever repetition work is carried on to any extent the thoughts of foundry managers turn to the moulding machines and their auxiliaries, such as sand conveyers, mixers, etc.

The lifting magnet is a modern appliance now being greatly used by founders for various purposes, such as lifting drops to break scrap, conveying pig-iron and castings of all characters. Where conditions are such that an electric crane can be run over a railway track, upon which pig-iron is delivered, a magnet can be made one of the greatest labour-saving appliances that is possible in a foundry. To have 100 tons of pig-iron unloaded in one hour, and no one called upon to do any more laborious work than to pull the lever of a crane calling for a lift of about 5 lbs., shows its great possibilities to a firm that can fairly utilise its power on this scale.

Stove Plate, Glassware Moulds and Machine Tools.

The stove plate branch of the trade as a specialty offers excellent opportunities for moulders and overseers, while the making of iron castings for moulds for forming glassware is very exacting work in demanding close grained and perfect solid metal in the castings. It is a line of work that has created specialties, in the making of the castings as much as in the die sinking or cutting of impressions in them. The surfaces that come in contact with the molten glass must be very dense, and to aid in attaining this, chills are now greatly used. Steel has been tried for making these castings, but owing to its oxidising easily when moulding the glass it could not be used.

Lathes, planers, punches and shears, comprise a class of castings requiring much machine finishing, which cannot be accepted if possessing defects to mar the highly finished working parts. Great improvement has of late years been made in the quality of these castings by the adoption of modern appliances, and improved shop practice.

Chilled and Sand Rolls.

Under the head of rolls we have demands for steel as well as iron. Steel rolls are made in all sand moulds, similar to what are called "sand rolls" made of iron. The greatest improvement of late years in these consists in methods of feeding to insure solidity in the upper end, cast body, and neck of the rolls.

The making of chilled rolls is one of, if not the most, difficult line of castings with which the founder has to deal. The difficulty is chiefly due to the great delicacy in the requirements of mixing and controlling the actions of the metal. The losses in the making of chilled rolls have no doubt exceeded many times those of other specialties that could be mentioned; but since the adoption of chemistry and improved practice by these founders their losses have been so greatly reduced that they are not now very far in excess of other hazardous lines. However, it is a work in which all details require the closest watching, and reflects great credit on the firm making a success of this specialty.

Power Accessories.

On the question of power transmission, the writer aims to cover several different specialties. The first includes that of making winding drums, pulleys, friction clutches, hangers, journal boxes, couplings, etc. The subject of cast and cut gearing, also, is no small specialty, and is one in which many advancements have been made in the gear moulding machines, which call for great accuracy in spacing the teeth and giving uniformity in all cross sections of the castings. Few lines of general castings of iron and steel are calling for a greater proportion of steel. There is little difficulty in making gears with the teeth cast in them, but in the blank gears there is no end of trouble due to ignorance and difficulty in feeding the shrinking metal. The work of feeding in its many phases can be truly called a science, and the lack of knowledge in this has caused great losses in founding. The needs and advancement of power transmission offer situations of much credit to men possessing sufficient intelligence and ability to become skilled in its various specialties of founding.

The castings used in the construction of cranes and locomotives are no small part of the tonnage turned out daily. Broad experience was demanded to perfect present practices, especially in the making of locomotive cylinders. One advance in these consists in their being made of the hardest grade of iron that can be machined.

The making of automobile, aeroplane and marine motor parts of iron, malleable and steel has created demands that have increased enormously in a short period of time. The castings used for these machines are, as a rule, very intricate in design and made as light as is possible to cast them. Great rivalry exists in striving to obtain iron and steel having strength and elasticity that will keep excelling past records. The founder's skill and ingenuity have been tried to their utmost in a strife to satisfy the demands of the automobile industry.

Die-Moulded Castings.

Permanent and die-moulded castings are now being made with much success. It is one of America's most modern advances, and is being extended to the making of a large variety of small castings that are required in large quantities. The difficulty with the production of permanent mould casting lies in the forced rapid solidification of the metal, which is apt to chill it, and the lack of freedom for contraction, after the metal has solidified. The chief trick in this process is to use soft grades of iron that have little tendency to chill, and to take the castings from their moulds as soon as solidification of the metal will admit of their removal. The fact that the contraction will not crack these castings will be best understood, when it is stated that a red-hot solidified casting has but about 25 per cent. of its total contraction, a discovery made by the writer in conducting his recent experiments in car wheels. The making of permanent mould castings is also to be credited with the casting of sash weights.

Heavy Work Moulding.

With responsibility comes trouble. The little things are hardest to manage. Nowhere are these axioms truer than in the making of heavy castings. Several men may work a week, or a month making a single casting, and the neglect of some apparently insignificant manipulation may cause the casting to be lost at the crucial test of pouring the mould. Imagine if you can, the mould of a casting over 100 tons in weight starting to blow metal skyward when being poured,

Some defects will not manifest themselves until the casting is removed from its mould or cleaned up.

Heavy work is made in green sand, often skin dried, dry sand and loam involving the use of brick. Heavy works calls for the highest skill of the moulder, and will never be made by moulding machines. A greater knowledge of the principles involved in moulding will permit experienced foundry and shop managers to better plan and direct work. With improved tackle for handling it, combined with the utilisation of chemistry, to render more assurance in obtaining proper metal, there is not the risk to-day that existed 20 years ago in the making of heavy castings. However, this is not to be taken as disparaging in the least the great need of experience, skill, judgment and care in the moulding of heavy castings, a work which will ever stand as par excellence of the founder's art, which offers a vocation calling for the highest qualities of the true mechanic.

The mixing and melting of cast iron, which is no little part of the founder's art, has made great advances in the past 20 years, largely through the introduction of chemistry, and the efforts of those making a research of cast iron. To obtain a tensile strength of over 40,000 lbs. per sq. in. in automobile piston rings, associated with great elasticity, is one of our modern advancements. The recent discovery and introduction of titanium and vanadium as alloys with iron, is greatly responsible for the additional strength and elasticity being now obtained by many founders in their castings.

Steel Castings.

The making of steel castings has caused the founder more worry, trouble, and expense many times over than what existed in the iron branch of founding. Steel is a metal that possesses about double the shrinkage and contraction that exists in iron. In this lies the steel founder's chief trouble. As this is greatly remedied through the design of patterns, method of constructing moulds, gating and feeding them and the quality of the metal, the responsibility for success rests more directly with the management than with the moulder.

Chemistry has a greater part in the making of steel castings than any other branch of founding, due to the great delicacy of steel, which changes its physical character more radically with little changes in its chemical composition than other metals. A young man obtaining a good training in iron moulding, can generally come to exceed the ability of one only trained in steel moulding, if he engages his services in this line. One of the hardest things to become accustomed to, in turning from iron to steel, is the removal of gates and feeding heads. The sawing and chipping necessary to remove them makes the iron man, unaccustomed to this work, nervous. He wants to get hold of a sledge and knock them off with a few blows, as he can do with iron, but instead must submit to seeing a saw grind away for an hour or so, to do what could be done in iron in a few minutes.

Cleaning and Welding Castings.

Modern advancement has made great strides in the cleaning of castings. Improved appliances have been introduced for cleaning and chipping in steel and iron castings, as well as in systems for handling the work. This is a department that should offer good situations to those of intelligence and ability to become competent foremen or inspectors.

Few advances have been more radical in the past years than the creation of methods for welding defective and broken castings. These have proven a boon to founders, in enabling them to save many castings that otherwise would have had to be sent to the scrap heap. We now have appliances or processes for welding by gas, and the electric arc. Cast iron is best welded by the gas process, because by this method we do not chill the fracture. The strongest weld is made by the electric butting process, as by this the least oxidation takes place.

A "butt weld," it is claimed, is stronger than adjacent bodies of the same cross section. The electric arc produces the greatest quantity of heat, and therefore is best adapted to large welding. All welding requires some experience and welding is a special vocation in a foundry.

Malleable Castings.

The malleable casting industry comprises about one-half of the number of foundries engaged in making steel castings, but like steel founding, it has had many vexatious trials, much experimenting and heavy losses in perfecting present practices. Difficulties are confronted in this line with shrinkage and contraction much as in steelwork. The evils of the former have been greatly remedied by the use of chills or iron bodies to form sections of the mould where the shrinkage prevailed. This modern remedy has also done good service in iron and steel, as well as in malleable castings. The use of malleable castings is greatly limited by reason of the "black heart" of malleable, which is commonly understood as being the interior body that is not all fully annealed. The thicker the section the worse this evil, and which has forced the regulating of thickness to the uniformity of the various cross-sections. One of the modern advances in malleable casting is the making of stove plate parts which are liable to breakage from use when made of cast iron. Malleable stove plate moulding is a very distinct line from all other branches of founding and has made great use of the moulding machine. It is another field offering good employment to the young man who will train for its service, and very creditable to those who grow able to master the business.

Presentation to Mr. T. Swinden.

At Sheffield, on April 22, before a meeting of the local Branch of the British Foundrymen's Association, Mr. T. Swinden, B.Met., late Honorary Secretary of the Branch, was the recipient of a presentation, in the form of a cheque, in recognition of his excellent work in the interests of the Association in Sheffield.

Mr. W. H. Hatfield read a brief address setting forth the indebtedness of the Branch to Mr. Swinden, who had done much to infuse new life into it.

The President (Mr. Percy Longmuir, B.Met.), said they were all heartily thankful to Mr. Swinden for the good work he had done during the time he held the post of Secretary. He was a scientist and metallurgist of considerable promise, and was known not only to every member of that Association, but throughout the metallurgical world. Whatever work he took in hand he always performed with marked ability. The members had decided to present him with a roll-top desk in recognition of the valuable work he had done, and he handed him the cheque for the purpose of making the purchase.

Mr. Swinden, who rose amid loud applause, expressed his gratitude to the members for their generosity. He believed the work he had done was successful to a certain degree, and he hoped the success they had attained would be continued.

The Value of Science to the Foundryman.

By T. H. Hawley.

Before the Lancashire Branch of the British Foundrymen's Association on April 1, a Paper on "The Value of Science to the Foundryman" was read by Mr. T. H. Hawley, of Manchester. An abstract is given herewith:—

There is a rooted idea in the minds of many people that the word "Science" is connected with something mysterious and which has no practical application. While this may apply to some kinds of science, the science of metals is better understood as knowledge systematised—knowledge of metals and metalloids arranged as general truths and principles. It is a department of knowledge obtained by the study of metals, by experiment, observation and common-sense reasoning, and the scope of its application is limited by the knowledge of how to apply it.

Grading by Fracture.

Grading by fracture has all along been the ruling factor in the selecting of pig-irons for foundry purposes, and while it is a difficult matter to change a rooted method, the writer will endeavour to at least show that a more definite and a surer method is needed. Of course, when known brands of iron are continually being used (and some can be relied upon) the examination of fracture is perhaps enough, but even here a change may occur in the elements, without notice. Many brands of iron which a few years ago could be relied upon for physical and chemical properties, do fail to-day. There are many districts producing ores which change very little in composition, and provided the blast furnace conditions are under control the quality can always be relied upon. The composition of an ore may be known, but the changing conditions of the furnace are not so readily known, and the latter may bring about variation in quality of brands from the same maker.

Grading by fracture is only of value when the iron is always produced and cast under the same conditions. Further, the presence of silicon and the amount decides the state of the carbon, low silicon giving high combined carbon, and high silicon the opposite. Sulphur can neutralise almost 15 times that of silicon; thus sulphur has a decided effect, and as phosphorus and manganese also play a part, the manganese, if fairly high, can somewhat neutralise the effect of sulphur. To sum up, we are bound to admit that fracture, apart from composition, won't tell us all we desire when buying pig-iron by number.

By blending various known brands of iron, say No. 3, in one mixing, we can get a fairly reliable quality, but unless the composition is constant we cannot always get the same result. The following will show this. These three brands of iron are each No. 3, but quite different in composition:—

No. 3 G.W.L.		No. 3 Lancashire.		No. 3 North Staffordshire.	
Si.	2.90	Si.	3.03	Si.	2.45
GC.	2.70	GC.	3.25	GC.	2.55
CC.	0.20	CC.	0.18	CC.	0.06
S.	0.05	S.	0.05	S.	0.08
P.	1.50	P.	0.67	P.	1.14
Mn.	0.60	Mn.	0.80	Mn.	2.30

The No. 3. Lancashire with its high silicon and total carbon would produce soft casting easy to machine, yet the G.W.L. would have a tendency to produce a harder casting in the same class of work, owing to its lower total carbon, and for this reason would produce drawn castings. Again, the No. 3 Staffordshire would on the same class of castings produce hard and brittle work owing to high manganese. These examples clearly show what may occur when composition is not known; each one of these is a good iron for certain classes of work, but for one class of work would produce quite different results. This shows that numbers cannot always be relied upon. It might be said that these are only approximate analyses. That may be, but it applies in the first brand as well as the third, and if we acknowledge, as we are bound to do, that the various elements have a great physical effect, then the question of numbering by the present method becomes more inaccurate still.

The vexed question of buying by analysis is not to the writer's mind as difficult as it is said to be. There are difficulties to be faced, no doubt, as there are in any proposed change, but all the difficulties seem to hang on extra cost of stacking, etc., and the other that foundrymen are not thoroughly prepared for the change, and not altogether agreed as to what lines that change shall take.

Scrap.

Before leaving fracture, I wish to deal briefly with scrap, because, in the selection of suitable metal it is essential that we should be careful with the scrap as well as the pig-iron. It is little use charging good pig-iron and bad scrap, because they won't blend to produce good results. One cannot fix any definite rule for this, but the following as regards composition is a good one to follow:—

	Heavy Machinery Scrap.	Light Scrap.
Si.	1.7 to 2.3	2.5 to 3 per cent.
Total C	2.45 to 3.0	3.0 to 3.5
S.	0.07 to 0.10	0.05
P.	0.44 to 0.99	1.0 to 1.5
Mn.	0.2 to 0.75	0.75 to 1.0

The various sorts of scrap that one has to use to-day in the foundry make it more desirable to have exact control over the charging and melting conditions. Many troubles can be traced to this, because unless furnace charges are constantly watched, they may easily cause unnecessary trouble by altering methods of charging, etc. A case in point may be cited. In buying scrap, especially in districts where it is not plentiful, one has to put up with good, bad, and indifferent sorts, such as kettles, pans, spoutings, burnt metal, etc. The writer, having a lot of this to use up a few years ago, the furnace man was given orders to use a little in each charge, the writer's method being to use a little shop scrap, heavy scrap and light scrap in each charge. The furnaceman, unfortunately, charged a quantity of the light scrap at one part of the blow, and the following day a number of the castings, whilst being hard to machine, showed white spots which could not be machined or filed, but which on knocking them out left small holes. The cause of this was eventually traced to the scrap, which, on examination, was found to be hard and with light grey streaks running through the metal. As this class of casting is generally run from highly phosphoric ores the white spots would probably be due to the cause explained by Mr. Stead. Large or small gas holes are formed as the casting is setting, and some of the liquid portion is forced into these holes, this liquid being the eutectic, which invariably has a large percentage of phosphorus present and is hard and of light colour. It is, however, not an easy matter to gauge properly the scrap used, and shop scrap becomes harder on

re-melting. The addition of silicon to low-grade scrap does not prove very beneficial unless the total carbon is fairly high.

The Influence of the Various Constituents.

The influence of each particular element is in many cases dependent on the amount of pressure, and this in turn may be neutralised in its effect by some other element. For instance, a brand of iron may have a certain amount of carbon present, but its influence will be controlled by the amount of silicon present. Silicon itself is a hardening agent, and only acts indirectly through the carbon, and whether it may be used as a guide in buying irons or not, it is certainly one of the main constituents.

Silicon and carbon are the two elements whose influence are most marked. The former ensures softness by reducing the amount of combined carbon, increases fluidity, lowers shrinkage, and, like aluminium, tends to keep occluded gases in the soluble form until the metal has solidified. As silicon determines the degree of hardness, its presence and control is necessary. For softness combined with rigidness, as in textile work, the following are two good examples, viz:—

Bestwood.		Glengarnock.	
Si.	2.75	Si.	2.3
GC.	3.20	GC.	3.0
CC.	0.15	CC.	0.5
S.	0.04	S.	0.04
P.	1.10	P.	0.60
Mn.	0.8	Mn.	1.0 Average ... 0.9

A mixing of these two brands with suitable scrap gives a splendid iron for textile or framing work. The high total carbon prevents a hard grain, the phosphorus promotes the fluidity, and the manganese gives soundness.

From a known mixture of these can be produced bars suitable for the welding of broken castings by the Thermit process. Hardness, strength and closeness of grain is derived from a composition as follows with the silicon under 2 per cent. The amount of silicon in iron required to have high transverse and tensile strength may be as low as 1.25:—

	Per cent.
Si. under	2.0
S.	0.1
P.	0.5
Mn	1.0
Total C. up to	3.0

This would be suitable for large valves, cylinders, hydraulic castings, or any class of work which has to stand severe tests. With a composition as above (other conditions such as temperature of pouring and gating being equal) a fine grained casting which does not sweat, and has not the same tendency to sponge is produced.

Manganese may be had in iron up to 3 per cent., the best average being about 1 per cent. for strong, clean work to bore well and show a hard silvery surface. Manganese also produces a more fluid iron, and when fairly high shows a bright, clear, metallic surface generally free from oxide. When it is present only in small amounts the surface is covered with rapidly moving films of oxide forming and re-forming, the size of the oxide break and its activity depending generally on the amount present. With manganese there is also less tendency to cold shot, but high-manganese irons invariably require a little more skimming owing to the lively surface. High phosphorus and high manganese will produce hard and rigid castings, rather low in deflection but good for wearing. Scotch irons are usually high in manganese, and have the reputation of carrying more scrap without hardening. The effect of manganese on sulphur is to neutralise its hardening and bad effects. The manganese combines as manganese sulphide, passing out of solution in the iron.

Sulphur and Phosphorus.

These two may be taken together because they are generally classed as impurities, more so than any other two. Sulphur itself is blamed for a great deal more than is warranted. It has its good qualities, but should always be kept below 0.10, because as the iron passes through the cupola the sulphur has a tendency to increase by as much as 0.02 per cent. But when the sulphur is fairly high, a pig-iron higher in manganese should be introduced.

The writer has met foundrymen who, while condemning sulphur have had great faith in adding burnt fire bars to a ladle of metal to produce hardness.

The writer recollects one particular foundryman who was in the habit of adding fire bars, and no

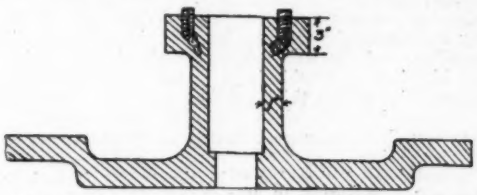


FIG. 1.—STUFFING BOX FOR HORIZONTAL ENGINE.

amount of reasoning could convince him that while he was blaming sulphur for a lot of his trouble he was adding it to his metal, and that it existed in its worst form as sulphide of iron. This class of scrap is very high in sulphur. These burnt bars often contain a lot of oxide of iron, which has the effect of oxidising and removing some of the silicon. Although sulphur increases the strength somewhat by increasing combined carbon, yet this method does not meet with favour amongst the average foundryman. The smell of sulphur is usually caused by the rising to the surface of the manganese sulphide; this sulphide may be

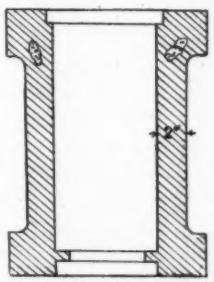


FIG. 2.—CAST-IRON CYLINDER TO STAND HYDRAULIC PRESSURE.

FIG. 3.—CYLINDER FOR RAIL-MILL ENGINE.

reacted upon by the oxygen of the air forming SO_2 which makes the odour stronger.

Phosphorus promotes fluidity and sharpness of castings with much detail, such as range work, etc., yet in castings with thick and thin sections it should not be high. The brands of iron celebrated for producing light castings owe their property in this direction to phosphorus.

Cast iron is a complex alloy of silicides, phosphides and sulphides, all these having various melting points, and therefore different solidifying points. They have a tendency as the amount increases to collect in the thickest and hottest portion of the castings (this, of course depending on the amount of the S. and P. present) as eutectic. In Figs. 1, 2, 3, the effect of the eutectic is shown, it causing spongy places. These are

actual cases caused by using irons high in phosphorus; the brands of iron used were otherwise perfect from a composition point of view. Fig. 1 was found to have a spongy portion on being drilled and tapped as shown, and after being bored was found to be soft and spongy on the inside. Figs. 2 and 3, after machining and on testing leaked, and after breaking were found hollow inside. This sponginess as a rule is brought about as follows:—As the thinner portions solidify they take up as much of the fluid portion as possible from the top, and while this is going on the upper or thicker portion of the crust nearest the outside is solidifying, the result being that when the still fluid portion in the interior begins to settle down there is no bulk to fill it up. A cavity or hollow is thus left, sometimes small fissures. Feeding and large heads do not always alter this. Chilling would in many cases ease the trouble, but would not remove it altogether, and the writer has no hesitation in saying that this class of trouble is in many cases one of composition. Sometimes thick portions are out of reach of a feeder or head, or chilling, and in cases like these one is bound to be more exacting as to the composition of the iron.

The amount of phosphorus in the types of castings shown, valves, condensers, and also in thick and heavy rollers, should not exceed 0.8, and in any case should be considerably below 1 per cent. Figs. 4 and 5 show the type of castings in which 1 per cent. of phosphorus

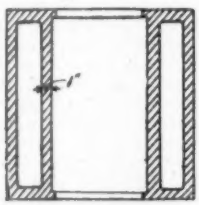


FIG. 4.—JACKETED CYLINDER.

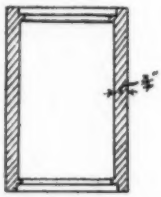


FIG. 5.—CYLINDER.

and even over is of benefit, because there is no difference in the thickness. This type of work needs fluidity, and also gets from that amount of phosphorus a certain amount of rigidity.

Fig. 4 is a casting to stand high pressure, and is turned and polished on the outside parts. Fig. 5, a card cylinder, is also machined and polished and drilled with numerous holes.

The foregoing will clearly show that from a practical standpoint the application of scientific knowledge is essential. Although science cannot always clear away the troubles that occur, yet in many cases it is half the battle.

Testing Cast-Iron.

The principal mechanical tests applied to cast-iron are the tensile-strength, transverse (noting deflection), hardness, shrinkage and compression tests. The relative value of each of these depends invariably on the size of test bar and the method of casting and cooling. For tensile tests the bars are generally about 12 in. long, turned down in the centre to ½ or ⅝, the ends being about 2 in. to form grips. Transverse test bars may be 12 to 15 inches long by 1 inch square, or a similar length, but 1¼ square, machined down to 1 in. square, and for larger tests 2 in. by 1 in. by 3 ft. centres. Hardness test bars may be cast square or rectangular, with one side machined, and then drilled with standard drills, with a known weight acting on the drills, the result being recorded on squared paper.

Shrinkage or contraction tests are best done by Keep's test, say on ½ in. test bars, the thickness of bar used being consistent with the general thickness of the castings produced. This would give more uniform results. If the castings are on an average ½ in. thick, a ½ in. bar should be used and if above a 1 in. bar is better. The results if taken down for everyday comparison are very reliable. Any variation if of any consequence can be read on applying the tapered scale.

For easy working qualities 128 to 132 should be got, and advance on these indicates hardness, these figures being shown by a silicon content of about 3 to 3.5 per cent; though other conditions may slightly alter this. In one set of bars tested by the writer showing high shrinkage, this was proved to be the result of over-blowing causing oxidizing conditions, reducing the graphite, combined carbon and also silicon contents. As to whether the carbon is attacked first or the silicon, the writer's experience is that the graphite is first reduced, and in this case would leave the silicon acting more directly, of itself producing with a lower carbon more shrinkage. After testing the bars mentioned, which showed shrinkages of 150 and 149, it was found that the castings also were somewhat hard and of a close grain. It afterwards transpired that the blast had been suddenly increased, causing the change noted; yet had it not been for the systematic daily testing, a more serious aspect would have arisen. A decrease of silicon invariably increases shrinkage, and *vice-versa*, and if shrinkage rises above 130 to 134 the silicon should be increased (if other conditions are equal). If the shrinkage goes below 128 more scrap or closer and cheaper irons can safely be used .

The K test is another means of regulating the soundness or freedom from sponge of various mixtures of iron. It is simple, efficient and easy to carry out, and by the different thicknesses of the test piece will show any tendency to sponginess or open-grained metal. If the analysis is known any variation, especially in those elements which are apt to form eutectics, will be shown in the thicker part or centre. While chemical tests are necessary to give approximate composition, mechanical tests also play a useful part and if carried out with any degree of system are bound to prove of benefit; but one cannot expect to get even comparative results by only taking occasional tests. Great care should also be taken to keep the bars of regulation size, as any slight increase has a marked effect on the result; a difference of 1-10th of an inch means about 1 cwt. more or less.

Discussion.

MR. PENLINGTON, in opening the discussion, paid a tribute to the excellent Paper. The question of the application of science in the foundry was not as easy as in the engineering or allied trades, as the "human element" had to be considered in the foundry more than in the other trades. No matter how complicated a machine may be it did not take long for a man to get used to it, and in many cases of engineering progress the human element was only a secondary matter, whereas in the foundry science could not displace the tempering of sand, because even the most skilled moulder could at times get his sand too wet or too dry, but it took experience to get it always of the right consistency for moulding. Whilst machine moulding displaced hand moulding, yet the average work still depended on the skill of the human element. The question of composition was at present not so vital as seemed to be, but the difficulty of buying by analysis was great. The amount of silicon in the examples of Bestwood and Glengarnock irons did not seem to be enough to produce the necessary fluidity for those brands of irons.

Mr. Robinson (Wrexham) said he was pleased that the Paper had dealt with the problem of the selection of pig-irons. He quite agreed with the writer in his remarks on fracture and composition, because owing to the various changes caused by different elements present, the fracture could not tell us all that was desired. He quite agreed also as to the effects of high P. As to the testing of cast iron, he had found that by using a test similar to Keep's he had been able to note at once any change in shrinkage or chill in his metal. The silicon content in the above-mentioned examples of iron he considered quite enough; the P. and Mn. gave the necessary fluidity, and for the class of textile work mentioned could not be beaten.

A Member stated that he had found that as regards P., about 0.9 gave the soundest and the best results, whereas over 1 per cent. had a tendency to cause sponginess, while also the transverse test came out better with 0.9 than with over that amount. The figures 150 on Keep's test seemed rather high. What was the cause?

Mr. Markland (Bolton) said he hardly thought that the P. content would have the effect stated, but the question of design in the Figs. 1, 2, and 3 would be the trouble, owing to the varying thicknesses; although at the same time the P. should be kept low for that class of work.

Mr. Hawley, replying to the discussion, said that while he did not lay claim to any special knowledge of the scientific side of foundry work, he recognised the need of a better and a surer method of mixing metals. As remarked by Mr. Robinson, the silicon content was quite enough along with the P. and Mn. to give the necessary fluidity, but the silicon content in the brands in question went to over 3 per cent. He (the speaker) quite agreed that 0.9 P. would give a better result and a sounder casting in the same class of work than 1 per cent. or more, and the actual cases shown in the sketches were put down to bring before foundrymen the evil that might be caused by high phosphorus. Mr. Markland had said that the design of the castings shown was the cause of the sponginess, or at least had a great deal to do with it. The design was no doubt against it, but castings of this class were on demand every day, and it was necessary to turn them out to the best advantage.

The meeting closed with a vote of thanks to the lecturer.

Case-Hardening.

From a pamphlet issued by Messrs. W. H. Palfreyman & Company we take the following notes on case hardening:—

The Material.

There seems to be a very general opinion that different qualities of case-hardening materials are necessary for different kinds of work, but our experience of over 20 years in making a speciality of case-hardening materials has taught us that hydro-carbonated bone-black is best suited to all classes of work, excepting where the merest surface case is desired and the uniformity of the work is of no material value, and then a common bone meal of the cheapest quality is used.

Where fancy mottled designs are required, which can be produced only by certain chemicals, of course, hydro-carbonated bone-black cannot be used, but wherever the toughest, finest and deepest case is desired, or wherever the ordinary colouring is all that is required, there is no material which can compare in either economy or quality with it.

Granulated raw bone is still used in some few places for case-hardening, but that it is not economical to use can be clearly proved. Carbon is the essential property necessary in case-hardening, and where raw bone is used the process of case-hardening will not commence until the raw bone is converted into charred bone, otherwise known as bone-black or animal charcoal. In converting raw bone into bone-black it loses slightly over one-third in weight; consequently there must be added one-third of the original cost, the cost of fuel in charring, the time, cost of plant, etc., to the first cost of raw bone in comparing it with a bone-black.

The ordinary forms of bone-black are not very extensively used owing to the fact that bone-black absorbs moisture very largely from the atmosphere, and moisture is very detrimental to the best results in case-hardening. The percentage of moisture absorbed depends very largely on the age of the black, humidity of the atmosphere, and other causes.

Burnt leather is somewhat used, but is very troublesome and quite expensive when cost of repairing is taken into consideration. Of all forms of burnt leather, old shoes undoubtedly give the best results as to colour. Care should be taken in using old shoes that metallic nails are not in the charred leather, as they will adhere to the work, and sometimes become so hard as to be removed only with the greatest difficulty. Leather, like bone-black, must necessarily lack uniformity, as it is waste.

A case-hardening material should be free as possible from soft dust, and the grains should be hard and firm, and under all circumstances the bone should be free from slate, slate being the result of over-charring, or the use of waste bone.

To manufacture hydro-carbonated bone-black, first is taken a pure white bone, particularly selected for its hardness, all pith and grease removed, and the bone then ground to a uniform size of mesh. The bone is then placed in closed retorts and charred by a uniform slow heat, the temperature being the same with every batch. As the bone comes from the retorts while yet hot and all moisture is excluded, it is immediately charged with rich carbon, extracted from a pure hydro-carbon oil. The pores are by this method filled with an oleaginous substance, which excludes all possibility of the absorption of moisture, and guarantees more pure carbon to the pound or square inch than is possible to obtain in any other material. The article is then ready for immediate use, and will keep indefinitely in any climate.

To Obtain Bright Hard Surfaces.

The pieces should be packed in wrought-iron boxes of suitable size for the work. For small work, say screws ¼ to ¾ in. or similar size pieces, a box 4 in. long, 4 in. wide, and 8 in. deep, should be used. A layer of hydro-carbonated bone-black should be placed in the bottom, then a layer of the pieces to be hardened, and this continued until the box is filled to about 2 inches from the top. The remaining space can be filled with black that has been used, providing it is free from moisture. The covers are then put on and luted with clay.

It is necessary that the boxes should have some little vent in order that the excess of gases caused by expansion should escape, and the clay will dry and crack, and permit this vent.

In packing it is necessary to be certain that none of the pieces come nearer to the sides of the box than ½ in. In packing pieces with irregular surfaces, or

with interior surfaces, such as the threads of nuts, the bone-black should be tamped into the crevices, but only lightly and not too tight.

The boxes should then be placed in a suitable furnace, or on a cricket, so as to permit a uniform circulating heat on all sides. The heat should then be gradually raised to a cherry-red, and retained at that heat as nearly uniform as possible for from three hours or more, according to the size of the pieces and the depth desired.

As the bone possesses the case-hardening power, the larger the pieces and the deeper the case, the greater the quantity of bone and the longer the heat necessary. For pieces 4 to 6 in. in diameter, the work should be packed in the hydro-carbonated bone-black, permitting at least 2 in. to surround each piece. the heat should be raised to a bright orange, and kept at that temperature for from three to five hours. The time allowed depends upon the depth of case required and the grade of iron or steel used. Steel can be hardened the same as ordinary iron, but the time and quantity of bone must be about one-quarter greater to obtain the same results.

The pieces, when ready to be removed from the boxes, should be immediately dumped into clear cold water, salt water being preferable for the larger pieces, and giving the hardest case. It is best to dump the entire contents of the box into the bath, holding the boxes as close to the surface of the water as possible, so as to prevent the air from striking the pieces. If the air does strike the pieces they will assume a black or blue-black colour, so that when a bright surface is desired it is necessary that no air shall strike the pieces.

A sieve placed about half-way down in the bath will permit the bone to separate from the pieces. The bath should be either large enough to guarantee the coldest possible water, or else so arranged that constant running water is obtained.

Colours.

Good colours can only be obtained on nicely-polished, clean pieces. Badly finished, oily work cannot be coloured properly. The pieces should be packed precisely as described before, using the same size boxes, proportion, etc., excepting that nothing but fresh hydro-carbonated bone-black should be used.

The boxes should be placed in the furnaces the same as before described, and the heat gradually raised to a cherry-red and retained at that temperature for from three to four hours. If the heat is too intense there will be no colour. The time can be increased or diminished according to the size of the pieces, and can only be determined by experience. The time above described is for pieces about the size of $\frac{3}{4}$ in. screws.

Soft water, though not necessary, is preferable for the bath. Running water should be attached, and the inlet should be about half-way down. The outlet should be about 4 in. from the bottom. The water must be kept as cool as possible. If ordinary streaked black or blue work is desired, the pieces should be dropped into the water at a distance of from 1 to 5 ft. above the surface of the water, the distance being according to the colour desired, and can readily be ascertained with a little experience.

For bright regular coloured work, an air pump should be connected with the supply pipe, so that when the pump is in operation the air and water mix as they come into the bath together. When dumping, hold the box as close to the surface as possible, so as to permit no air to strike the pieces. When the pieces are dumped a stream of air and water should be running into the tank. Increasing and diminishing the volume of air gives different effects.

As the work comes from the boxes free from the bone, the pieces should be thoroughly rinsed in fresh water, wiped perfectly dry, and then slushed with oil. Rolling in sawdust is a good method of drying.

Annealing.

The process of annealing is simpler and less difficult than that of case-hardening. It requires less hardening power from the bone, and consequently the waste or used bone from case-hardening can be used in this process. In fact, the bone-black can be repeatedly used again and again, adding each time a little waste that has not been used more than once.

The pieces should be packed in boxes, the same as for case-hardening, excepting that it is not necessary to use such care in keeping them thoroughly apart.

The boxes should be placed in the oven and heated through to a cherry-red. They should be removed without permitting them to remain too long in the ovens, and be covered with ashes, charcoal, or waste bone-black until they are cold. Under no circumstances should the pieces be removed from the boxes until they are thoroughly cooled. This process is for a soft anneal.

General Information.

Owing to the various methods of case-hardening, the different results desired and the difference in the metal, no one set of rules can be formulated that will meet all requirements. Experience must guide the operator to a great extent.

If the pieces do not harden sufficiently at one operation, they should be repacked and hardened again in precisely the same manner as at first, and there is no limit to the number of times the operation can be repeated. Frequently it is more economical, more effective, and quicker to harden twice where an exceedingly deep case is required, than it is to attempt to obtain the case with one hardening.

Those unfamiliar with case-hardening or doing irregular work will find the indicator, otherwise known as the tell-tale, useful. This consists of a piece of round metal, of the same quality as that being hardened, so arranged that it extends down into the centre of the box, through the cover, in which there must be a hole to permit this. The hole must be luted with clay the same as the cover. When the operator believes the work sufficiently hardened he can quickly remove the indicator and plunge it and then break it and ascertain the depth of the case, or by use of a file ascertain the surface hardness. More than one indicator can be used in the same box.

An economical method of drying the bone after it has been dumped into the bath, is to put it back into the boxes, and place them in the ovens without their lids, after the fire has been withdrawn, when the remaining heat will dry the bone as the ovens cool.

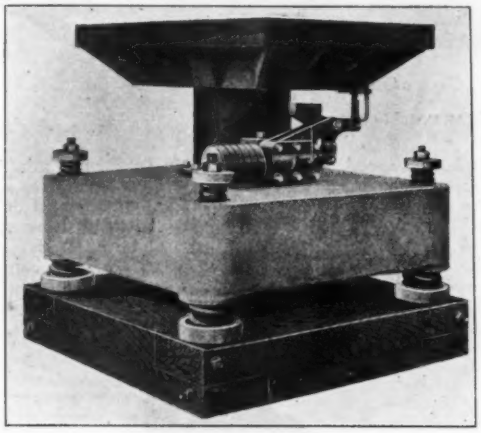
Hydro-carbonated bone-black, when used once, parts with a large percentage of its case-hardening power. If, therefore, it is mixed with fresh material, it adulterates that accordingly. There is, of course, some case-hardening power left in bone that has not been used, but just what percentage of the waste bone, if any, can be mixed with the fresh bone must be ascertained by the judgment of the operator. The best and quickest results can only be obtained with the fresh material.

Wrought-iron boxes should be used, as cast iron being very porous absorbs the hardening properties of hydro-carbonated bone-black quicker than wrought iron.

Foundry Plant and Equipment.

A Shockless Jolt Ramming Machine.

The machine shown in the accompanying illustration is one of the Osborn Manufacturing Company's jolt ramming machines. It is provided with a heavy cast-iron shock-absorbing bed-plate or anvil, which obviates the necessity of installing heavy foundations, other than the embedded timbers through which the bolts are passed for the anvils and grips, and which are held by heavy washers under the timbers. The anvil is held in suspension by four pairs of springs, the springs of each pair being separate. The lower set of springs prevents any transmission of vibration to the foundry floor, while the upper set prevents rebound. The tension of the springs is easily adjustable by the nuts on the bolts passing through the timbers. The cylinder of the machine is bolted to the bed plate or anvil, and the moulding machine is delivered intact



OSBORN'S SHOCKLESS JOLT RAMMING MACHINE.

for installation in the foundry floor. The anvil of the machine shown in the accompanying illustration weighs six tons.

Stewart's Wheel-Moulding Machine.

The accompanying illustration shows a style of wheel moulding machine which has, it is claimed, the advantages of being self-contained, simple, and accurate. The machine is made in only one size, which is capable of moulding spur or bevel wheels with any desired number or pitch of teeth, from 1 ft. to 10 ft. diameter, and of any desired breadth up to 42 in.

The essential feature of the machine is the large cast-iron drum mounted on the upper part of the vertical spindle. This drum has 50 rows of bored holes—the first row contains 51 holes and the last 100, each succeeding row having one more hole than the one before it. These holes are all accurately bored in a dividing machine, and as this is the only part of the machine

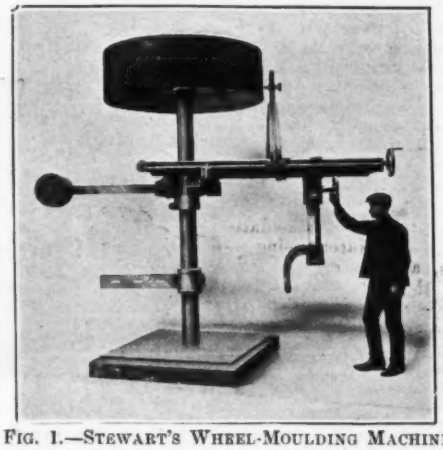


FIG. 1.—STEWART'S WHEEL-MOULDING MACHINE.

where inaccuracies can arise, special precautions are observed to eliminate all chance of error. The action of the other parts of the machine will be readily understood from the illustration. No change wheels or temporary attachments of any kind which are liable to become mislaid or lost are needed, and the machine, as a whole, can be lifted by the crane and removed to

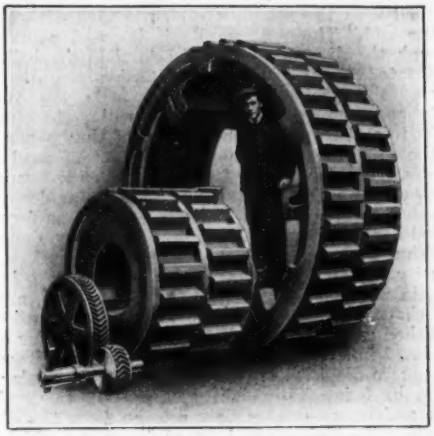


FIG. 2.—GROUP OF GEARS MOULDED ON STEWART'S MACHINE.

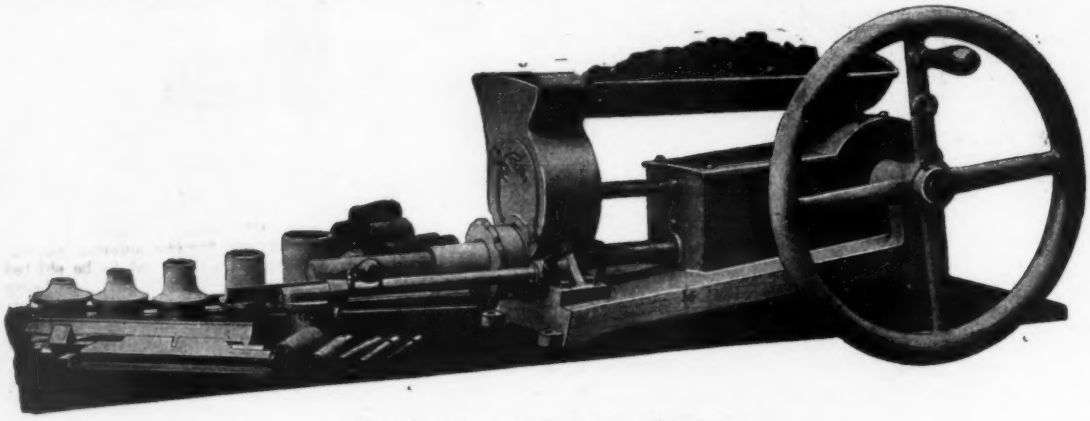
any part of the foundry while the arms of a wheel are being moulded.

The makers of the apparatus are Messrs. D. Stewart & Company, Limited, London Road Iron Works, Glasgow.

The "Perfect" Core-Making Machine.

The core-making machine shown herewith is designed with a horizontal plunger for making circular, square, rectangular, oval or other shapes of cores, the length of core which can be made being practically unlimited. No screw or worm is employed for the core-making, the claim of the makers being that the design is an improvement on the worm-conveyor type. The apparatus consists of a gear box containing bevel gears for working the plunger (the lower of the two rods shown) and for rotating the shaft to which is attached the sand mixer revolving in the hopper shown in the illustration; a die of the desired size, held in position by a nut; and a vent needle inserted through the die and passing through the centre of the plunger, and held in position by a thumb-screw at the back of the gear-box. Six vent needles of various diameters are supplied with the machine, each provided with a ball at one end. The vent needle is inserted point first through the die and is clamped so that the ball end is situated about half an inch inside the die. By varying the position of the vent needle, the core is made more porous or less porous at will. The plunger works to and fro across the bottom of the hopper and on the forward stroke rams a quantity of sand into the die. The forward end of the plunger is furnished with hooks which on the return stroke tear down the end of the core, leaving it jagged, and thus forming a good key for the next lot of sand rammed up against it. Thus a compact, jointless core is produced. The capacity of the machine is for cores from ¼ in. to 3 in. in width, of uniform section throughout, and of any shape, but the machine as usually supplied is furnished with six circular dies and plungers for cores of ⅝ in., 1 in., 1¼ in., 1½ in., 2 in. and 2½ in., diameter, one square die 1 in. by 1 in., and one rectangular die 1½ in. by ½ in., with eight guide plates to fit these cores and bear them as they emerge from the die.

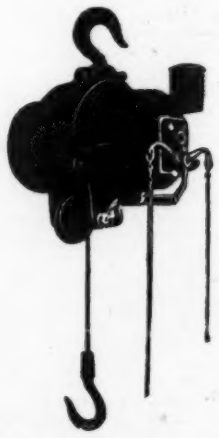
Among the claims put forward for this machine are that it cannot get out of order, and that it can be worked by a boy, and will produce a core 12 in. long in 10 seconds. No oil is required in the sand, unless river sand be used. The machine is entirely independent of the skill of the operator. The makers for Great Britain and the Colonies are Messrs. Humpage, Thompson & Hardy, Bristol, and the selling agents, Messrs. J. W. & C. J. Phillips, 23, College Hill, London, E.C.



THE "PERFECT" CORE-MAKING MACHINE.

Pneumatic Motor Hoists.

In foundries where compressed air is installed the use of pneumatic hoists for handling materials of every description is a valuable convenience, greatly facilitating the progress of the various operations. Herewith is shown one of the pneumatic hoists made by Messrs. John Macdonald & Son, Limited, Watt Street, Maryhill, Glasgow. These hoists are made in several sizes, with capacities ranging from 10 cwts. to 10 tons, based on a pressure of 80 lbs. per square inch, the speed of lift being 40 to 60 ft. per minute for the small size and ranging according to size for the larger ones, the 10-ton hoist having a speed of 5 to 7½ ft. The shortest distance between hooks in the case of the former is 23 in., and in the case of the latter 41 in., the regular heights of lift being, respectively, 9 ft. and 10 ft. The weight of the smallest size of this apparatus is about 240 lbs., and that of the largest 515 lbs. The consumption per minute of free air ranges from 50 cubic ft. for the 10-cwt. hoist to 190 cubic ft. for the 10-ton apparatus.



PNEUMATIC MOTOR HOIST.

Inventions.

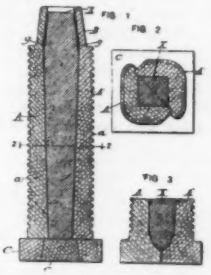
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

4,387. Process of and apparatus for making castings in steel, brass, phosphor bronze, etc. J. Vaughan-Sherrin.
5,015. Alloys and the manufacture thereof. (International Metal Products Company, United States.)
5,065.*Furnaces. E. Glaser and F. Preilsler.
5,140.*Smelting furnace with electric refining hearths connected thereto. A. Helfenstein.
5,257. Furnaces for heating, puddling, smelting, roasting, calcining, etc. A. Smallwood.
5,423. Chaplets for all foundry cored work. J. E. Grace.
6,158. Electric furnace for two- or three-phase currents. A. L. Billon-Daguerre.
6,301.*Purifying cast-iron and steel. B. L. B. dit Reyer.
6,889. Apparatus for mixing liquid steel. H. Crowe and T. C. Hutchinson.
6,936.*Device for preventing the breaking of emery stones. F. Eickmann.
of fuel. E. W. Smith.
7,370. Manufacture of steel. T. D. Mackie and G. F. Forwood.
7,384.*Methods of producing cast-steel blanks, billets, bars, plates, etc. W. McConway.
7,411. Sand-blasting machines. W. Kenyon.
7,540. Method of producing castings such as box pipes, axle boxes, etc. F. J. Shenton and H. Custance.
7,663.*Production of alloys by the employment of highly fusible substances. Titan Ges. m. b. H. and G. Meissner.
7,730. Flux for brazing cast iron. H. O. Herring.
7,863. Metallic alloys. J. F. Duke.
7,890. Manufacture of iron or steel. A. Williams and C. P. Williams.
7,968. Furnaces. A. H. Gibbings.
8,180. Treatment of moulds for making metal castings. A. Poulson.

Abstracts of British Patent Specifications recently accepted.

25,844 (1910). *Casting Ingots.* E. Gathmann, 15, William Street, New York, U.S.A.—Figure 1 shows a vertical central section through an ingot mould embodying the improvements with an ingot therein; Figure 2 shows a transverse section on the line 2—2 of Figure 1. Figure 3 shows a modified way of forming the lower portion of the mould. The mould is divided vertically or longitudinally into two sections, A A^1, which have an interlocking connection with each other, as shown in Fig. 2. The mould sections may rest on a stool C, or the base of the mould may be formed as indicated in Figure 3. The lower portion of the mould is provided with ribs *a*, which, as shown in Figure 1, may extend horizontally around the outside of the mould. The walls of the neck B are thinner than the walls of the body of the mould, the neck being formed integrally with the lower portion of the mould. The heavier walls of the body of the mould prevent any material outward expansion and enlargement of the ingot mould chamber as they remain comparatively cool, and thus ensure relatively close contact with the hot ingot walls, whereas the thinner walls of the necked-in upper portion B are heated through and expand more readily, thus enlarging the upper part of the ingot chamber and providing a relatively large clearance or air space around the upper part of the hot ingot. The mould chamber, as shown, is made to taper from its lower end upwardly and outwardly to the line *g* at the base of the neck, and from this line it tapers upwardly and inwardly to the top of the ingot. By this construction after the metal is teemed into the mould approximately 85 per cent. of the ingot X during its shrinkage remains in close contact with the walls of the mould, while the upper part of the molten ingot as it shrinks draws away from the walls of the mould, and thus an air space is formed which materially assists in preventing the radiation of heat. The ratio of taper is preferably greater in the upper part of the mould than in the lower part. In the case of ingots of large diameter or those cast of alloys in which the sidewise shrinkage is excessive, in



Apparatus for Casting Ingots.

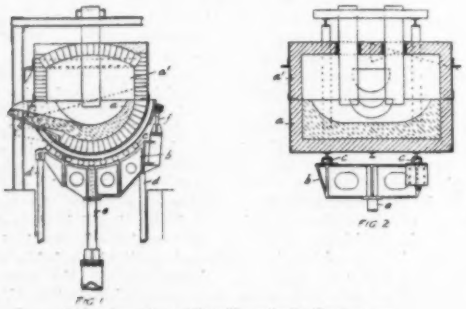
order to insure close contact of the lower side walls of the ingot with the corresponding inner side walls of the retaining mould, the stool C is constructed with a removable centre piece C^1, which is adapted to be slightly lowered to compensate for the sidewise shrinkage, or, if desired, it may be constructed to be shifted sidewise and entirely removed while the ingot is being cast and while its central portion is still fluid, but after its outer lower portion and side walls have been solidified.

8,530 (1910). *Manufacture of Steel Alloys.* C. M. Johnson, 733, Orchard Street, Avalon, Allegheny County, Pennsylvania, U.S.A.—The invention consists in charging into the furnace for the manufacture of the steel, together with the other steel making ingredients, tungsten, from which the silica of the native rock has not been refined away, and in slagging out the silica so introduced during the steel-making process. Certain of the ores of tungsten, namely, wolframite ($MnFeW.O_4$), and huebnerite ($MnWO_4$), have in prior processes of producing tungsten oxide, been subjected to the operation of fusion. The patentee has found that by the acid operation, he can obtain the desired oxide without incurring the greater expense involved in the fusion operation. The mineral is taken in its concentrated form—either one of the ores named above, or another tungsten ore, for example scheelite ($CaWO_4$), or iron tungsten ore ($FeWO_4$). With the concentrated ore there will be a certain amount of dross, consisting largely of silica derived from the rock in which the ore is found. A quantity of such ore is charged into a retort, together with a chlorine-affording substance. This chlorine-affording substance will preferably be a relatively small quantity of an alkaline chlorate (chlorate of sodium or chlorate of potassium the ratio of chlorate to ore being about 1 to 100). To this charge is added hydrochloric acid, preferably in the commercial form known as muriatic acid, in the ratio of about 125 to 150 pounds of mineral to 111 pounds of 20 degrees acid. While the ensuing reaction is in progress, the temperature of the retort and its contents is maintained at about 90 degrees C. The desired reaction will be completed after an interval of from 10 to 18 hours, at the end of which period the liquid is decanted from the solid residue, and that residue is washed in water. The washing is continued until the soluble constituents are removed; that is to say, in the case of wolframite until the wash water contains but a slight trace of manganese, or in the case of scheelite until the wash water contains but a very small quantity of calcium. This residue consists of tungstic acid mixed with insoluble dross, which ordinarily will largely consist of silicic acid or silica. When the operation of reduction has been carried out, and the charge of the reducing furnace been cooled down and withdrawn, that charge will consist of metallic tungsten in finely divided form, somewhat caked, mechanically mixed with dross

or adulteration which, as above explained, will to a large extent consist of silica. The tungsten content of the resulting product will ordinarily be about 80 per cent. of the whole.

11,839 (1910).—*Process for the Cementation of Articles of Iron, Steel, and Alloys of Steel.*—Firm Societa' Anonima Italiana Gio. Ansaldo Armstrong & Company, of Genoa, Italy.—This invention provides a process for the cementation of articles, whereby a layer of desired depth more highly carburised than the remainder of the article, may be produced in the zone situated immediately below the external surface of the article. The articles are put into the cementing chamber, which is placed in a furnace capable of heating it to a constant and uniform temperature between the limits of 900 and 1,100 degrees Centigrade. The chamber is provided with an airtight door, and with pipes arranged to cause a current of carbon dioxide to circulate slowly through the chamber. The process is started by placing a layer of carbon in the cementing chamber. It is preferred for this purpose to use wood charcoal that has been thoroughly calcined and reduced to small pieces. The size of the pieces of the granulated charcoal and the thickness of the layer of such charcoal vary according to the varying dimensions, quantity, and shape of the articles to be cemented. For instance for cementing at one operation 100 kilogrammes of pieces of steel not too complicated in shape (such as, for instance, ball bearing races, axles of bicycle wheels, etc.), no one piece should exceed 40 to 50 grammes in weight. With the said portion of the charcoal a first layer is formed having a depth about 10 to 15 centimetres. The articles are then placed upon the first layer of charcoal, at a distance of from one to two centimetres apart. Upon the articles placed as described, a quantity of granulated charcoal is poured so as to cover them completely. Upon this new layer of charcoal, other articles to be cemented are placed and covered with more granulated carbon, and so on, until the cementing chamber is filled. Dioxide of carbon re-acts at a high temperature on the carbon according to the following equation: $CO_2 + C = 2CO$, transforming into gas an equivalent of carbon, and forming (for each volume of dioxide of carbon) two volumes of monoxide of carbon. This new gas is diffused in the iron and by reaction forms carbide of iron which effects the carburation of the steel and regenerates the dioxide of carbon according to the following equation; $2CO + 3Fe + Fe_3C = CO_2$.

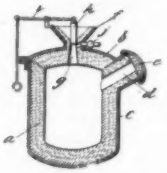
6,036 (1910). *Furnaces for Metallurgical Purposes.* R. O. Ahlers, Avenida Palace Hotel, Lisbon, Portugal. —Figure 1 is a transverse vertical section of the furnace and tilting arrangement; Figure 2 is a longitudinal sectional elevation. The lower part *a* of the furnace is



Furnace for Metallurgical Purposes.

constructed semicircular in form, and is supported upon a frame *b*, carrying trunnions *c*. This frame is provided with guides *d*, so that it may be raised or lowered with the lower part of the furnace containing the hearth by the rams *e*, actuated by fluid pressure so as to be always directly in line with the upper structure a^1 of the furnace. This frame *b* is also provided with rams *f*, likewise actuated by fluid pressure for tilting the semicircular hearth to the required degree, so that the centre of oscillation is always in vertical line with the upper portion of the furnace. By this arrangement a large part of the radiant heat from the hearth *a* will be received in the upper chamber a^1 during the process of raising, lowering and tilting of the lower part of the furnace, thereby avoiding thermal losses both in the chamber of the furnace and in the hearth, and likewise preventing the metal from becoming chilled.

29,482 (1909). *Manufacture of Steel.* A. Reynolds, Birkbeck Bank Chambers, Southampton Buildings, London, W.C.—The object of this invention is to obtain steel of any desired character from a charge of suitable constituents and proportions by dead melting as in the ordinary crucible process, and to effect this the reduction and alloying of the charge is conducted under conditions which preclude any injurious reactions between the charge and the lining and slag in contact therewith at the temperature necessary for the completion of the reactions between the oxidised charge of steel and the alloying and reducing materials. The dead melting is effected in a ladle, crucible, or furnace having a lining of hearth which is at once chemically inert and sufficiently refractory, and under a slag which is either inert or acts beneficially as a deoxidiser. In obtaining such linings and slags the inventor takes advantage of the fact that the three very refractory basic substances—alumina, lime, and magnesia—are not attacked by the desirable constituents of steel at steel-making temperatures. Further, these substances, and also silica, are not peroxidisable, and consequently these substances or mixtures thereof with or without silica in addition will not act catalytically or catephorically to transmit oxygen from the atmosphere or furnace gases to the charge of steel, and while it is to be noted that silica is itself attackable by the desirable constituents of steel, it is not attacked, or only



Improved Process for the Manufacture of Steel.

to a slight extent, when combined with one or more of the bases mentioned to form a basic mixture. In carrying the invention into practice, when desirable, the possibility of transference of atmospheric gases is also still further reduced by conducting the dead melting *in vacuo*, and a further advantage of doing so resides in the tendency to eliminate occluded gases and increase the reducing power of carbon at furnace temperatures *in vacuo*. When the dead melting is effected in a ladle, a ladle of special construction is used, which is shown in section in the accompanying cut, and consists of a body portion *a* or ladle proper and a lid *b*. The iron casing *c* of the ladle is lined with one of the beforementioned refractory substances, and is provided with a neck *d* similarly lined. The neck *d* is provided with a lid *e* which is lined preferably with plumbago, and suitable provision is made for securing the lid *e* on the neck to close it air-tight. Provision is made for effecting an air-tight joint between lid and ladle. Surmounting the lid *b* is a hopper *f* which is lined preferably with plumbago, and communicates with the interior of the ladle by an aperture *g* in the lid which can be closed by means of a plug *h* actuated by a lever *i* or other suitable means. A pipe connection *j* fitted with a stop cock may be provided leading to the interior of the ladle and adapted to be coupled with a suitable pump or other exhausting apparatus whereby a vacuum may be produced within the ladle.

Trade Talk.

A COMPULSORY winding-up order has been made against the Cone Jackson Engineering Company, Limited, 118, London Wall, E.C.

MR. ROWLAND HODGES, brassfounder, of 12, Frederick Street, Birmingham, has removed to 132, Brearley Street, Birmingham.

THE AUDLEY ENGINEERING COMPANY, LIMITED, of Newport, Salop, have closed their branch at 31, Queen Street, Wolverhampton.

THE FALCON BRASS WORKS, LIMITED, are being wound up voluntarily, with Mr. P. Butchart, 49, Queen Victoria Street, E.C., as liquidator.

MR. J. PHILLIPS, Miles Lane, London, E.C., has acquired the patterns, etc., of the Adderley Brassfoundry Company, Limited, Birmingham.

THE STEELMAKING METALS COMPANY, metal merchants, Town Hall Chambers, 87, Fargate, Sheffield, will in future be known as the Tungsten and Alloys Company.

A FIRE occurred on April 20 last, on the premises of James Clews & Sons, Limited, brass founders, Aston Road, Birmingham. Considerable damage was caused.

BEFORE the members of the Staffordshire Iron and Steel Institute, at Dudley, on April 8, an interesting paper, on "Electric Furnaces," was read by Mr. Verdon O. Cutts.

MESSRS. F. J. MORGAN and W. D. DAVIES, engineers and manufacturers' agents, 30, Wind Street, Swansea, trading under the style of Morgan & Davies, have dissolved partnership.

MR. A. MITCHELL, JUN., 144, St. Vincent Street, Glasgow, has been appointed Scottish agent for the steel wire, tool steel, etc., of Peter Stubs, Limited, of Warrington and Rotherham.

WE are informed that the works of Benjamin Bunch & Sons, Walsall, which have been stopped about six weeks, have been acquired by Messrs. J. and W. Marshall & Company, of Smethwick.

BABCOCK & WILCOX, LIMITED, who now specialise in steel works' cranes, have just secured the contract for a platform type open-hearth charging machine for Steel, Peech & Tozer, Limited, of Rotherham.

MESSRS. W. WILKINSON and J. CRITCHLEY, carrying on business as iron and brass founders, at Hindley, in the county of Lancaster, under the style of the Hindley Foundry Company, have dissolved partnership.

THE COOPER-STEWART ENGINEERING COMPANY, LIMITED, have acquired the British business of the Chicago Flexible Shaft Company, which is carried on at 11, Denmark Street, Charing Cross Road, London, W.C.

THE UNITED STATES METALLIC PACKING COMPANY, LIMITED, of the Soho Works, Thornton Road, Bradford, have opened a branch office at 2, Collingwood Street, Newcastle-on-Tyne, in charge of Mr. H. B. Plummer.

MESSRS. T. ROWLANDS & COMPANY, British agents for the Titanium Alloy Manufacturing Company, of Pittsburg, Pa., U.S.A., have removed from 99, Banner Road, Sheffield, to Stirling Chambers, Campo Lane, Sheffield.

MESSRS. SCHONFIELD & COMPANY (London), iron, tinplate, and metal merchants, 10, Byward Street, Great Tower Street, London, E.C., have been appointed sole British and Colonial agents for the sale of "Zig-Zag" milling files.

A MEETING of the Birmingham local section of the Institute of Metals was held on March 28, Mr. G. A. Boeddicker in the chair. The Chairman announced that the Council had decided to establish a branch for associates, for the benefit of those employés who could not afford full membership.

A MEETING of the Sheffield Electro-Metallurgical Society was held at the Applied Science Department, Sheffield University, on April 7, Professor Arnold, the President, in the chair. Four members of the Society read short papers, under the general title of "A Symposium of Workshop Problems."

THE business of Andrew Gray & Company, metal merchants and manufacturers, Govanhaugh Works, 555, Govan Street, Glasgow, has been sold to Mr. J. D. Gray, the only son of the late Mr. Andrew Gray, who was the sole partner. Mr. J. D. Gray will continue the business under the same name.

A PETITION has been presented by the Anderston Foundry Company, Limited, to the First Division of the Court of Session at Edinburgh for confirmation of a resolution passed by the company reducing the capital from £300,000, in £10 shares with £6 paid, to £180,000, in £6 shares, by cancelling the new capital.

THE partnership heretofore subsisting between Messrs. A. Westwood, T. H. Westwood, J. Freakley, and J. W. Bailey, carrying on business as engineers, iron-founders, and machinery brokers, at the Acme Foundry, Church Lane, West Bromwich, Stafford, under the style of Bailey, Freakley & Westwood, has been dissolved.

A MEETING of the shareholders of the Tuckingmill Foundry Company Limited, will be held at 50, Gresham Street, Bank, London, E.C., on Monday, May 29, for the purpose of having the account of the liquidator, showing the manner in which the winding-up has been conducted and the property of the company disposed of, laid before them.

A FIRE, resulting in heavy damage, occurred at the works of the Midland Coal, Coke & Iron Company, Limited, Apedale Ironworks, Newcastle-under-Lyme, Staffs., on the evening of the 20th inst. A block of buildings, comprising saw mill, wagon-shop, and pattern-making shop, were destroyed. No disturbance of employment has, however, resulted.

IN the Chancery Division, on March 31, before Mr. Justice Swinfen Eady, an application was renewed on behalf on the plaintiffs in the debenture holders' action of Davies *v.* the Company, for the appointment of a receiver and manager of the Priory Foundry, Limited, of Carmarthen, manufacturers of agricultural implements and iron founders. His lordship gave judgment in favour of the plaintiffs.

IT is reported that a new company is being formed with which Duckham & Cloudsley, Limited, Newton, Chambers & Company, Limited, Gibbons Bros., Limited, and Thomas Vale & Sons, Limited, will be associated, for the building of vertical retorts on the Woodall-Duckham continuous system. The company, we understand, will trade under the style of Woodall-Duckham Vertical Retort Construction Company.

MR. D. CARNEGIE, of Messrs. David Carnegie & Gladwyn, consulting engineers, 33 and 35, Charterhouse Square, London, E.C., who has been acting for some years as consulting engineer to Samuel Osborn & Company, Limited, of Sheffield, will continue with the company for special work. Messrs. Carnegie & Gladwyn have now established themselves in business as consulting engineers.

THE statutory meeting of the Machine Tool and Engineering Association was held on March 29 at the Midland Hotel, Manchester. Mr. J. T. Peddie, who presided, said the principal object for which the Association was formed was to control and limit the number of engineering exhibitions. The directors had agreed with promoters of rival exhibitions at Olympia for 1912 and 1913 to cancel them and to join in the management of an exhibition under the direction of the Association. It was intended to make that exhibition as international in character as possible. The Board of Trade had authorised the statement that an international exhibition would probably be held at Winnipeg in 1914, and it was likely that the Association would be asked to organise the British engineering section there.

THE creditors of Mr. M. S. Stevenson met at the London Bankruptcy Court recently. The debtor, an undischarged bankrupt, had engaged in the metal trade, principally in connection with the manufacture of bronze and white metal, in Birmingham and London. He had traded as the Birmingham Foundry Company in partner-

ship with another, who found the capital. He paid his partner out at the end of eighteen months, but in 1905 he joined Mr. J. Melland Smith in partnership and traded together as the Birmingham Foundry Company. In 1907 the business was sold to the Bronze and Silver Metal Company, Limited. That business was in 1909 taken over by the British Bronze Company, Limited, Birmingham, of which he was a director He returned his liabilities at between £5,000 and £6,000, principally due for money borrowed, and no available assets. In the absence of an offer the case was left to the Official Receiver to wind up in bankruptcy. The public examination is fixed for May 16.

The Corrosion Research Committee of the Institute of Metals is now actively engaged in preparing for an elaborate series of investigations into the causes of the corrosion of brass condenser tubes. A special condenser is being constructed, which will contain 48 tubes, 24 of these being made of commercially pure brass, the remaining 24 tubes being made from brass containing a single selection from the following: lead, tin, aluminium, manganese, or other materials at the discretion of the committee. Experiments will be made with various water speeds in the ratio of 0, 1, 2, 3, 4, speed 2 being an average speed used in practice. The circulating water to be used will be obtained from deep water at Formby, off Liverpool, in the first instance, and the plant for the corrosion research will be installed in the University of Liverpool, where the experiments will be under the direct supervision of Mr. G. D. Bengough, M.A. It is expected by the committee that the research will prove to be one that will occupy many months before any definite conclusions can be reached, and the research will undoubtedly be costly. An appeal was recently made by the committee for funds to carry on the research, and in response to that appeal donations have been received, amongst others, from Muntz's Metal Company, Limited, Broughton Copper Company, Limited, Sir Gerard Muntz, Bart., Mr. L. Sumner, J. Stone & Company, Limited, Yorkshire Copper Works, Limited, Mr. J. McKechnie, Sir W. H. White, K.C.B., Mr. A. F. Yarrow, Mr. T. R. Bayliss, and the New Delaville Spelter Company, Limited. Though the total amount received (£242 5s. 6d.) is sufficient to enable the research to be commenced, the committee state that the cost must ultimately be very much greater than this amount. If the research is to be properly carried on, the expenses will probably amount to not less than £300 per annum.

New Companies.

Murray Foundry Company, Limited.—Capital £2,000 in £1 shares.

F. Usher and Company, Limited.—Capital £1,000 in £1 shares, to carry on the business of ironfounders, etc.

Wellman, Head, Stotherd, & Pitt, Limited.—Capital £100 in £1 shares, to carry on the business of engineers, etc.

E. R. Hough, Limited.—Capital £2,000, in £1 shares, to carry on the business of dealers in marine and engineers goods, etc.

Morgan Grate & Furnace Company, Limited.—Capital £1,000 in £1 shares. Registered office: 17, Gracechurch Street, E.C.

Manchester Furnaces, Limited.—Capital £2,000 in £1 shares. Registered office: Globe Works, Barruthers Street, Ancoats, Manchester.

George Bailey & Sons, Limited.—Capital £1,000 in £1 shares, to carry on the business of engineers, &c. Registered office: 2, Berry Street, Wolverhampton.

Staniar Clegg & Co., Limited.—Capital £1,000 in 500 ten per cent. preference shares of £1, and 10,000 ordinary of 1s., to carry on the business of engineers, &c. Registered office: 112, Portland Street, Manchester.

Kelly & Anderson, Limited.—Capital £8,000 in £1 shares, to acquire the business of Kelly & Anderson, engineers. Registered office: 400, Pollokshaws Road, Glasgow.

Bomford & Company, Limited.—Capital £1,000 in £1 shares, to carry on the business of brassfounders, etc. Registered office: 59, Lower Essex Street, Birmingham.

J. W. & C. J. Phillips, Limited.—Capital £15,000 in £1 shares (4,000 preference), to carry on the business of mechanical engineers, etc. Registered office: 23, College Hill, London, E.C.

James Walker & Company, Limited.—Capital £45,000, in £10 shares, to carry on the business of engineers, &c. Registered office: Lion Works, Garford Street, West India Dock Road, E.

Spiral Bond Bar Company, Limited.—Capital £500 in 1s. shares, to carry on the business of manufacturers of and dealers in metal, etc. Registered office: 70, Chancery Lane, London, E.C.

Engineering Improvement Company, Limited.—Capital £5,000 in 4,000 ordinary shares of £1 each, and 4,000 deferred shares of 5s. each. Registered office: 39, St. James Street, London.

Ferguson & Timpson, Limited.—Capital £10,000 in £1 shares, to acquire and carry on the business of engineers, oil merchants, etc. Registered office: 50, Wellington Street, Glasgow.

W. W. Battye & Sons, Limited.—Capital £3,000 in £1 shares, to take over the business of W. W. Battye & Sons, Victoria Ironworks, Holmfirth, Yorks. Registered office: Victoria Ironworks, Holmfirth, Yorks.

George Clark & Sons (Hull), Limited.—Capital £50,000 in £10 shares, to take over the business of a coppersmith, brassfounder, and metal merchant carried on by C. C. Clark at the Alexander Copper and Brass Works, Waterhouse Lane, Hull, as George Clark & Sons.

Francis W. Birkett & Sons, Limited.—Capital £3,000 in £1 shares (1,000 preference), to act as founders, finishers, patternmakers, etc., and to acquire the business carried on at Cleckheaton as Francis W. Birkett & Sons.

Smith Brothers & Company (Glasgow), Limited.—Capital £30,000 in £10 shares (500 5 per cent. cumulative preference), to carry on business as engineers and machine tool makers. Registered office: 71, Park Street, Kinning Park, Glasgow.

Bi-Metals, Limited.—Capital £5,000 in 10s. shares, to carry on the business of dealers in metals, alloys and metallic compounds, engineers, etc., and to adopt an agreement with Neville, Williams & Company. Registered office: 31, Bridge Row, E.C.

J. W. Pickering & Sons, Limited.—Capital £8,000 in £1 shares, to carry on the business of ironfounders, engineers, etc., and to acquire the business carried on at 41, Sefton Street, 20, Parliament Street, and 1, Hill Street, Liverpool, as J. W. Pickering.

W. J. Stanley & Company, Limited.—Capital £5,000 in £1 shares, to take over the business of ingot brass and metal manufacturers, etc., carried on as W. J. Stanley & Company, at 28, Freeth Street, Ladywood, Birmingham. Registered office: 28, Freeth Street, Ladywood, Birmingham.

E. Parkes & Company, Limited.—Capital £40,000 in £1 shares, to take over the business carried on at the Atlas Iron Works, West Bromwich, as E. Parkes & Company, and to carry on the business of iron, brass, and gun metal founders, etc. Registered office: Atlas Iron Works, West Bromwich.

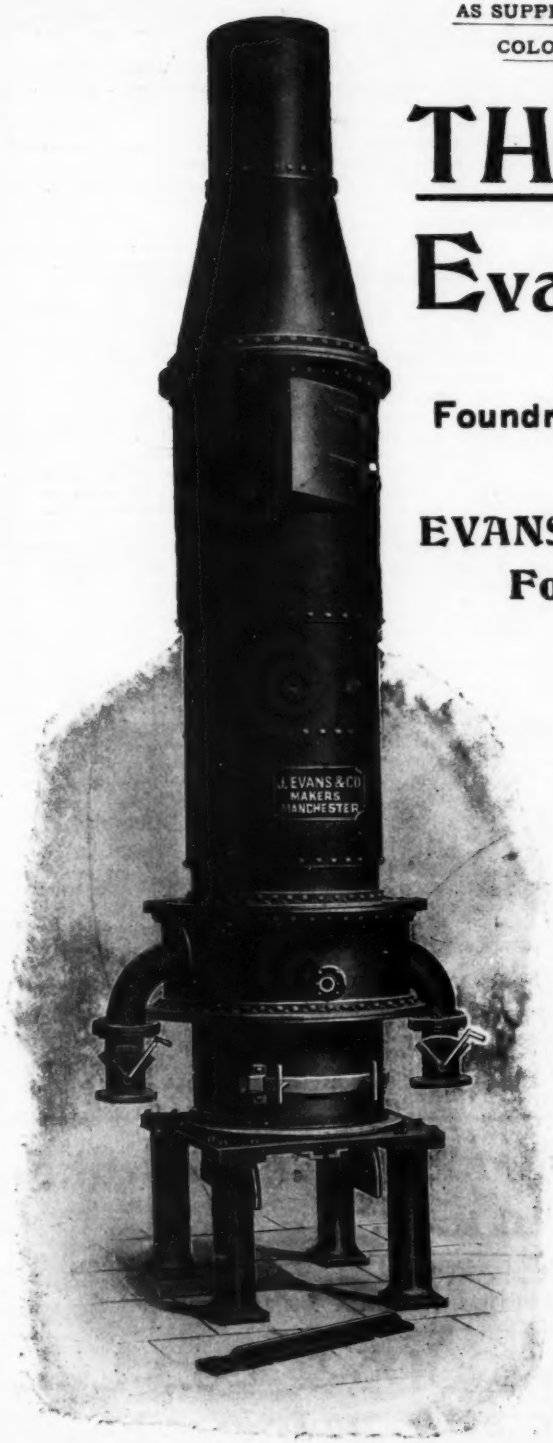
Player & Mitchell, Limited.—Capital £15,000 in £1 shares, to take over the business of naval and railway brassfounders, etc., carried on at Cambridge Street, Birmingham, as Player & Mitchell, and to adopt an agreement with S. W. Mitchell. Registered office: Attwood Passage, Cambridge Street, Birmingham.

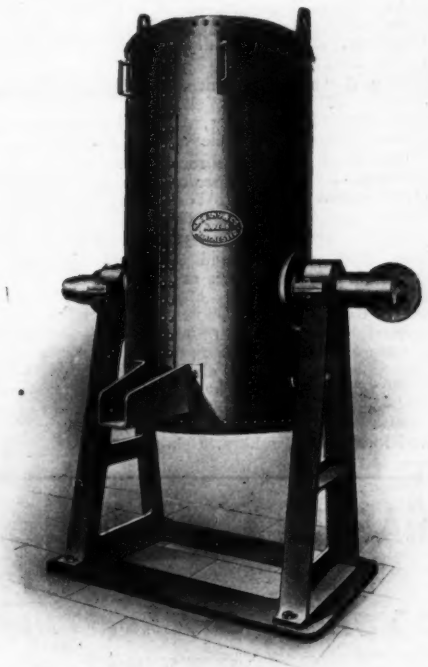
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE, COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

Deaths.

THE death has occurred at Attercliffe, Sheffield, of Mr. T. Clarke, ironfounder.

THE death is reported of Mr. W. Bruce, of Messrs. Bruce & Sons, engineers, Bootle.

MR. H. DENTON, of the Loxley Steel Works, Sheffield, died recently, at the age of 60 years.

MR. W. HAWKINS, who established the firm of Hawkins & Company, ironfounders, etc., Dudley Port, died recently, aged 84 years.

THE death has occurred, after a short illness, of Mr. W. H. Pratt, retired ironfounder, at his residence. Woodlands Cottage, Pontllanfraith.

MR. B. HAIGH, at one time a partner in Messrs. Chadderton, Allmark & Haigh, brassfounders, Dukinfield, died recently, aged 65 years.

THE death took place recently of Mr. J. J. Muxlow, who established the firm of Muxlow & Knott, steel makers, Sheffield, at the age of 74 years.

THE death took place recently of Mr. W. J. Elliott, a director of Elliott & Garrood, Limited, Ingate Ironworks, Beccles, at the age of 45 years.

MR. R. H. C. NEVILE, of the Nevile Engineering Company, Limited, Piston Foundry, St. Martin's Gate, Worcester, died recently, aged 61 years.

THE death is announced of Mr. J. A. Drake of Messrs. Drake & Fletcher, West Borough and Medway Iron Works, Earl Street, Maidstone, at the age of 70 years.

MR. W. J. WALLIS, London manager for Marshall, Sons & Company, Limited, of the Britannia Ironworks, Trinity Street, Gainsborough, died recently, after a brief illness.

THE death has occurred at Ingleside, Leigh, of Mr. John Sims, of the firm of Messrs. Picksley, Sims & Company, Butt's Foundry, Leigh. The deceased was in his 62nd year.

THE death is announced of Mr. A. J. Gimson, a director of Gimson & Company (Leicester), Limited, engineers, ironfounders, and boilermakers, Vulcan Street, Leicester, at the age of fifty-seven years.

THE death took place recently of Mr. C. E. Greaves, a director of A. B. Bosher & Company, Limited, crucible steel makers, Carbon Works, St. George's Square, Broad Lane, Sheffield, at the age of fifty-four years.

MR. R. H. TAUNTON, of Brook Vale, Witton, Birmingham, died recently, aged 80 years. Early in life, the deceased gentleman was entered for service with Fox, Henderson & Company, of the London Works, Smethwick. Owing to the Company getting into financial difficulties, Mr. Taunton had to seek a new situation, and became manager of the foundry department of Messrs. Cochrane & Company, of Woodside Iron Works, near Dudley, and for them he superintended the erection of various bridges. In 1862 he bought the Star Tube Works. This concern grew in his hands, and was later well known as Taunton, Delmard & Lane.

Personal.

THE will of the late Lord Airedale has been proved provisionally for one million sterling.

MR. E. H. GARY, chairman of the United States Steel Corporation, emphatically contradicts the report of his retirement.

MR. H. STRATHERN, manager of the Glasgow branch of James Milne & Son, Limited, has been transferred to the works at Abbeyhill, Edinburgh.

THE late Mr. E. H. Linley, a director of Wm. Jessop & Sons, Limited, has left £10,000 to the Sheffield University for educational purposes.

THE late Mr. J. H. Houldsworth, a director of the Coltness Iron Company, Limited, left personal estate in the United Kingdom valued at £327,507.

MR. GEORGE RITCHIE, at present steel works manager to Wm. Beardmore & Company, Limited, Glasgow, has been appointed manager of Messrs. Bolckow, Vaughan & Company's blast furnaces, iron and steel works, at Middlesbrough and South Bank, and will enter on his new duties on July 1 next.

THE Bessemer gold medal of the Iron and Steel Institute will this year be awarded to Professor Henri le Chatelier, the eminent French metallurgist, in recognition of his services in the advancement of metallurgical science. The presentation will be made by his Grace the Duke of Devonshire, President of the Institute, at the annual general meeting, to be held in London this month. The Andrew Carnegie gold medal for 1910 will also be awarded at the same meeting, the recipient being M. Felix Robin, Paris.

Legal.

Midland Railway v. Beeston Foundry Co.

Mr. Justice Hamilton, sitting in the King's Bench Division on April 25, had before him the action of the Midland Railway Company v. Beeston Foundry Company, Limited, of Beeston. The action was brought in respect of the balance of payments due to plaintiffs for goods carried for the defendants. The accounts extended over the period since 1902, and had relation to the charges made for carriage of radiators for defendants from Beeston to various parts of the country. Certain deductions had been made from time to time by the defendants in payment of their accounts, and the railway company were endeavouring to recover amounts they contended were due to them. The total charges for goods carried for defendants amounted to £34,265, and the amount now claimed was a balance of £1,352. Ultimately his Lordship rose to give the parties an opportunity of discussing the terms of a settlement.

(*Continued on page* 294.)

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

SOUND

STRONG, CLOSE-GRAINED

CASTINGS

Obtained by using

"TITANIUM THERMIT"

TINS READY FOR USE. **ALL SIZES from 2 cwt. to 20 tons.**

Prices and Particulars from

THERMIT LIMITED,

Telegrams: "FULMEN, LONDON."
Telephone: 3749 Central.

Works: **210a, Bow Rd., E.**

27, Martins Lane,
Cannon Street, E.C.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time. We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

When the hearing was resumed on April 26, it was stated that the parties had arrived at a settlement, and there would be judgment by consent for £1,250 for the plaintiffs. The counter-claim was withdrawn, and it was stated that an understanding had been arrived at in regard to future charges by the railway company.

Johnstone v. Associated Ironmoulders of Scotland.

In the Bill Chamber of the Edinburgh Court of Session, recently, answers were lodged to the note of suspension and interdict at the instance of J. Johnstone, ironmoulder, Glasgow, against the Associated Ironmoulders of Scotland, and also against the trustees of the Association. The complainer asks that the respondents should be interdicted from applying any part of the funds of the Association and from levying or collecting moneys from members of the Association for the promotion of representation in Parliament. He also asks interdict against the respondents making payments from the funds to the Labour Party or paying the election expenses of candidates for Parliament. In their answers the respondents state that under the rules all questions between the complainer and the Association must be determined by arbitration, and they maintain that the question now at issue between them, being one within the terms of the reference, the complainer is barred from taking the present proceedings. The respondents admit that in March, 1907, a resolution was passed making provision for running a Parliamentary candidate and for imposing a special Parliamentary levy of one shilling per member per annum on all members of the Association, and that the Executive Council proceeded in October, 1907, to impose the levy. The legality of these proceedings falls to be determined in the manner provided by the rules, but the complainer has taken no steps to have the question raised by him determined by the Arbitration Committee, as he contracted and bound himself to do when he became a member of the Association. The Parliamentary levy was enforced by the Executive up to the October quarter, 1909, when the Executive Council decided that the levy should not be imposed for the succeeding quarter.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past wo years :—

METALS.	End Apl., 1911.	End Apl., 1910.
Iron—Scotch pig warrants ton	*52/7½	*53/7½
—Middlesbro' warrants ton	46 9	47 7½
—W.C. M/nos Bessemer ... ton	65 6	57 0
—Stock, Scotch ... ... tons	1,000	1,000
Copper—Chili bars, GMB ton	£54 16 3	£56 5 0
—Stock, Europe and afloat tons	—	—
Tin—English ingots ... ton	£192 0 0	£134 0 0
—Straits ... ... ton	£194 5 0	£132 5 0
—Stock, London, Holland, U.S.A., and afloat ...tons	—	—
Lead—English pig ... ton	£13 3 9	£13 15 0
Spelter—Ord. Silesian ... ton	£24 1 3	£21 12 6
Quicksilver (75lb)... bottle	£9 0 0	£8 7 6
Antimony—Regulus ton	£35 0 0	£30 0 0 £31 10 0

* Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

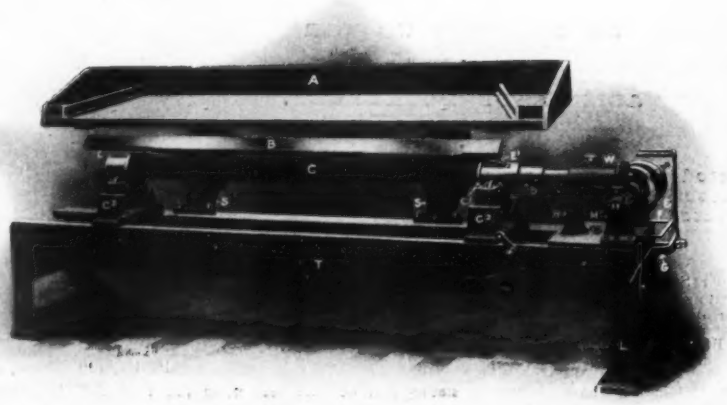
	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1½ to 2½ in.	4 17 6	to	5 2 6
,, 3 to 4 in.	4 10 0	to	5 0 0
,, 5 to 8 in.	4 7 6	to	4 10 0
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 12 6	to	3 15 0
Floor plates (open sand)	3 0 0	to	3 5 0

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows :—Heavy wrought (mixed), £2 10s. 0d.; light wrought, £1 7s. 6d.; heavy cast-£2 7s. 6d.; all per ton, f.o.b., London. Copper (clean), £51 10s. 0d.; brass (clean), £38 0s. 0d.; lead (usual draft), £12 0s. 0d.; zinc, £18 15s. 0d.; all per ton delivered merchant's yard.

Core-Forming Machine

(W. JONES' PATENT).



For making sand-pipe cores from 10 inches to 10 feet, and any diameter from 1 inch to 20 inches.

Cores made in half the time and at half the cost of the old system.

Jones & Attwood, Ltd., Engineers, Stourbridge.

Established 1863.

JAS. DURRANS & SONS,

PHŒNIX WORKS, PENISTONE, Near Sheffield.

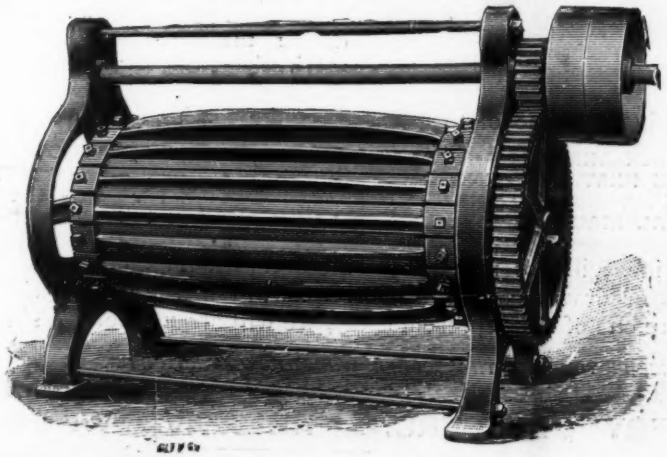
Manufacturers of all

FOUNDRY EQUIPMENTS,

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



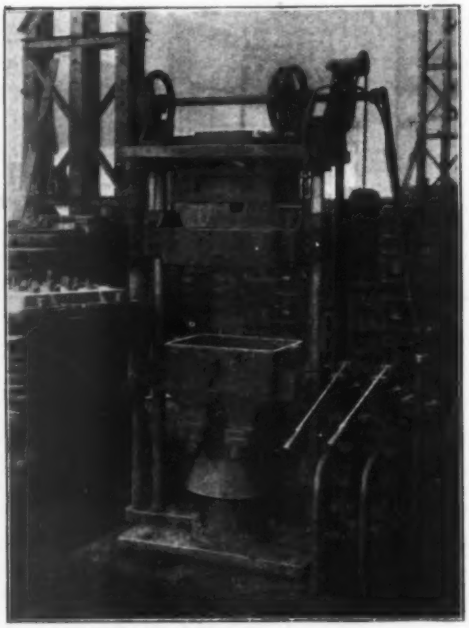
These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

Plate Moulding with Snap Flasks . .

is used extensively for dealing with light castings in all departments of the foundry trade. It is without question a very rapid method of moulding, and taken in conjunction with the fact that the snap flask does away with moulding boxes it is not surprising that the system is growing in favour. In point of output many power Moulding Machines can show an advantage over plate moulding, but this is over-balanced by the cost of the necessary boxes, the maintenance expenses and the floor space required for storing them.



¶ In the "LEWCO" BOXLESS HYDRAULIC MOULDING MACHINE we have the snap flask or boxless system combined with a power ramming moulding machine. It is the most complete machine in existence, for it rams both halves of the mould simultaneously, draws the pattern, cuts the runner and gates, closes the mould, and delivers it ready for receiving the metal. ¶ As both halves of the mould are made simultaneously and compressed to an equal extent, much truer and better castings result than when each half is made separately. Correctly located pins and holes in the moulding boxes and pattern frames ensure accurate closing and prevent overshut castings.

¶ The rate of production is such that no man with a plate and a snap flask can possibly compete. 200 moulds a day is quite ordinary and, in some cases, the rate of production with two youths amounts to 400 moulds in eight hours.

¶ One firm to whom we have supplied several of these machines is obtaining four times the output they were formerly getting by plate moulding. Another is getting two and a half times the output, whilst a third will be obtaining double the quantity of moulds they were previously getting from pneumatic machines.

¶ The following is some of the work that the machine is doing :—

SEWING MACHINE ARMS. GRATE BARS. BOILER DOORS AND FITTINGS.
STOVE PLATE CASTINGS. AIR BRICKS. BRACKETS.
COTTON AND SPINNING MACHINE FITTINGS. MANGLE PARTS. COLLIERY TUB WHEELS.
AGRICULTURAL MACHINE FITTINGS. LAWN MOWER FITTINGS. ETC., ETC.

The machine will not make any and every casting, but if you will send us sample castings or drawings of your work we will tell you what it will do, or if you would like to see one of our representatives, we will arrange for a visit.

THE QUICKER YOU ACT THE SOONER WILL THE SAVING BEGIN.—WRITE TO-DAY.

EMERY GRINDERS. ABRASIVE WHEELS.

THE LONDON EMERY WORKS Co., PARK WORKS,
TOTTENHAM, LONDON, N.

THE BUYER'S GUIDE

Addresses and further information will be found by reference to the Firm's Advertisement.

Abrasive Wheels.
Evans, J. & Co.
London Emery Works Co.
Jackman, J. W., & Co. Ltd.

Air Compressors.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Electrically Driven).
Jackman, J. W., & Co., Ltd.
Marshall & Co. Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Steam).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Belt).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Annealing.
Evans, J. & Co.
Phillips, J. W. & C. J.

Ash Crushing and Washing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Barrels (Tumbling).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Tilghman's Patent Sand Blast Co., Ltd.

Barrows.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.

Bellows.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Durrans, Jas., & Sons.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Blacklead.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Blowers.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Buffalo Forge Co., Ltd.
Davies, T., & Son.
Dempster, R. & J., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Samuelson & Co., Ltd.
Thwaites Bros Ltd.
Ward, T. W., Ltd.

Buffing and Polishing Machines.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Casting Cleaners.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Pneumatic Engineering Appliances Co., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Cement.
Dyson, J. & J.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Lowood, J. Grayson, & Co., Ltd.
Marshall & Co., Horace P.
Olsen, Wm.
Plasti-Kion Co.
Silent Machine and Eng. Co.

Chaplets and Studs.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Motherwell, Wm., & Co.
Olsen, Wm.
Wilkinson, T., & Co., Ltd.

Charcoal.
Evans, J., & Co.
Firminger, J. & Co., Ltd.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Sykes, James.
Walker, I. & I.

Charging Platforms.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Thwaites Bros., Ltd.

Coal Dust.
Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Sykes, James.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.
Williams, John (Birmingham Sand) Ltd.

Coke (Foundry).
Elders Navigation Collieries.

Coke Breakers.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W., & C. J.

Core Boxes.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.

Core Compounds.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Wilkinson, Thos. & Co.

Core Gums.
Durrans, J. & Sons.
Evans, J., & Co.

Core Gums—*cont.*
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd

Core Making Machines.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
Jones & Attwood, Ltd.
London Emery Works Co
Marshall, H. P. & Co.
Phillips, J. W. & C. J.

Core Ovens.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Jackman, J. W. & Co., Ltd.
Jones & Attwood, Ltd.
London Emery Works Co.
Phillips, C. D.
Phillips, J. W. & C. J.

Core Ropes.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, T. & Co.

Core Vents.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Cranes.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
Vaughan & Son, Ltd.
Ward, T. W., Ltd.

Crucibles.
Evans, J. & Co.
Hall, Charles, & Co.
Olsen, Wm.

Crucible Furnaces.
Alldays & Onions Pneumatic Eng. Co., Ltd,
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Crucible Furnaces (Lift-out)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

Crucible Furnaces (Tilting)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Crushing Mills.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Cupolas.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T. & Son.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Marshall, H. P. & Co.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Cupola Linings.
Evans, J., & Co.
Hall, Charles & Co.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Emery Grinders.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davis, T., & Son.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Emery and Glass Cloth and Glass Paper.
London Emery Works Co.

Emery Wheels.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Mitchells Emery Wheel Co.

Facings.
Evans, J. & Co.
Olsen, William

Fans.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Buffalo Forge Co.
Davies, T. & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Jenkins, W. J. & Co., Ltd.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Firebricks.
Durrans, J. & Sons.
Dyson, J. & J.
Evans, J. & Co.
Fyfe & Co., J. R.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
King Bros.
Lowood, J. Grayson, & Co., Ltd.
Pearson, E. J. & J.

Foundry Blacking.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Firminger, J. & Co., Ltd.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Sykes, James.
Olsen, Wm.
Walker, I. & I.
Wilkinson, Thos. & Co., Ltd.
Williams, John (Birmingham Sand) Ltd.

Foundry Brushes.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, C., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Phillips, J. W. & C. J.

Foundry Ladles.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
McNeil, Chas.
Phillips, J. W. & C. J.
Thwaites Bros. Ltd.

THE BUYER'S GUIDE.—*Continued.*

Foundry Rattlers or Fettling Drums.
Alldays & Onions
Davies, T., & Son
Durrans, J., & Sons
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co.
London, Emery Works Co.
Marshall & Co., Horace
Phillips, J. W. & C. J.

Foundry Sand.
Dyson, J. & J.
Evans, J., & Co.
Gould, George
Jackman, J. W., & Co., Ltd.
Wilkinson & Co., Thos., Ltd.
Williams, J. (Birmingham Sand), Ltd.

Furnaces (Annealing).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Furnaces (Brass).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Furnaces (Melting).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Ground Gannister.
Durrans, J., & Sons.
Dyson, J. & J.
Evans, J., & Co.
Lowood, J. Grayson, & Co.
Walker, I. & I.

Grinding Machines and Tools.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Jones & Attwood, Ltd.
London Emery Works Co.

Hammers (Steam).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Thwaites Bros., Ltd.

Hay Band Spinning Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall &Co., Horace P.

Hoists.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Loam and Sand Mills.
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Ward, T. W., Ltd.

Melting Furnaces (Oil fired).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Mould Driers.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Moulding Machines.
Adaptable Moulding Machine Co., The
Britannia Foundry Co.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Pickles, James.
Pneumatic Engineering Appliances Co., Ltd.
Samuelson & Co., Ltd.
Whittaker, Wm., & Sons, Ltd.

Moulding Machines (Hand and Power).
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Pickles, James.

Pig Breakers.
Evans, J., & Co.
Jackman J. W., & Co., Ltd.
London Emery Works Co.

Pig-Iron.
Bradley & Sons, T. & I., Ltd.
Frodair Iron and Steel Co., Ltd., The
Goldendale Iron Co., Ltd.

Plumbago.
Cumming, Wm. & Co., Ltd.
Durrans, J., & Sons.

Plumbago—*cont.*
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd,
London Emery Works Co.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Pneumatic Tools.
Jackman, J. W., & Co., Ltd.
J. Macdonald & Son, Ltd.
Marshall, H. P. & Co.
Pneumatic Engineering Appliances Co., Ltd.

Polishing Sundries.
Evans, J., & Co.
London Emery Works Co.

Publications.
Eagland & Co., Ltd.
Griffin, Charles & Co., Ltd.

Pyrometers.
Alldays & Onions
Phillips, J. W. & C. J.

Recording Gauges.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W & C. J.

Riddles.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, Thos. & Co., Ltd.

Sand Blast Apparatus.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Phillips, J. W. & C. J.
Tilghman's Patent Sand Blast Co., Ltd.

Sand Driers.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Phllips, J. W. & C. J.

Sand Grinding Mills.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.

Sand Mixers.
Evans, J., & Co.
Halls Eng. Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Sand Riddling, Separating and Sifting Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P. & Co., Ltd.
Pneumatic Engineering Appliances Co., Ltd.

Sieves.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Smiths' Hearths.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Marshall & Co., H. P., Ltd.
Samuelson & Co., Ltd.
Thwaites Bros., Ltd.

Steel Moulders' Composition.
Dyson, J. & J.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Lowood, J. Grayson, & Co., Ltd

Spades and Shovels.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Stone Flux.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Wilkinson & Co., Thos., Ltd.

Stoppers and Nozzles.
Dyson, J. & J.

Straw Ropes.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, William.
Wilkinson & Co., Thos., Ltd.

Testing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.

Tuyeres (Firebrick).
Dyson, J. & J. [Ltd
Lowood, J. Grayson, & Co.

Welding. Thermit, Ltd.

FOR
IRONFOUNDERS' BLACKING, COAL DUST, ETC.
Registered "SHALAGO" Brand.
Write for Quotations to—
WILLIAM CUMMING & Co., LTD.,
IRONFOUNDERS' FURNISHERS.
WORKS— { Kelvinvale, Mills, Maryhill, Glasgow.
Whittington Blacking Mills, Chesterfield, Eng
Sunnyside Blacking Mills, Falkirk, N.B.
TELEGRAPHIC ADDRESSES— { "Prudence, Glasgow."
"Cumming, Whittington, Chesterfield."
"Cumming, Blacking Mills, Camelon."

SITUATIONS VACANT AND WANTED.

IRON MOULDER Wanted. Used to Small Marine Work.—Apply PLENTY & SON, LTD., Newbury, Berks.

FOREMAN MOULDER (smart) seeks engagement. Constructional, Pumps, Valves, General Engineering, Machine, and Plate. Expert Metal mixer. Good organiser. First-class references.—Box 502, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

YOUNG Man desires Situation as ASSISTANT FOUNDRY MANAGER or ASSISTANT FOUNDRY FOREMAN in Modern Engineering Works. Thorough practical and technical experience. Possesses Diploma of International Correspondence Schools for Foundry course. Also Certificates for complete Foundry course at Municipal Technical College. Member of B.F.A. Well up in the Analysis and Chemistry of Metals. Practical experience in Engineering, Millwright, Machine Tool, and Plate Work. Total abstainer. Good timekeeper. First-class references.—For further particulars apply to Box No. 500, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

EXPERIENCED FOREMAN PATTERN-MAKER, about 9 men. Must thoroughly understand Pattern-making and Moulding. None but experienced men need apply. Age, experience, and wages expected.—Address Box 505, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

WANTED, WORKING FOREMAN for Core Bench. Must be one experienced in Motor Cylinders. State age, experience, and wages required.—Address Box 507, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED.

WANTED, for Cash, Brass and Gun-metal Scrap Turnings, Condenser, and Loco. Tubes, Brass Dust, Mixed Metals, etc.—RAPID MAGNETTING MACHINE COMPANY, LTD., Crescent, Birmingham.

CHAINS for every purpose, including Mine and Incline Chains, Crane and Sling Chains, Steam Navvy and Dredger Chains, manufactured from tough and fibrous iron by skilled workmen.—MID-BRITISH CO., Corngraves Works, Cradley Heath.

A NEW "CUPOLA FURNACE."

THE Proprietor of the Patent No. 2,130, of 1910, relating to a

NEW "CUPOLA FURNACE,"

desires to

DISPOSE OF THE PATENT,

or to

GRANT LICENSES

to work thereunder.

Several very good references could be already furnished,

Inquiries to be addressed to A. MENAGER, 607 Sherbrooke W.Str., Montreal, Canada.

FRODAIR SPECIAL PIG-IRONS

Some Recent Tests of

FRODAIR MIXTURES.

TENSILE
(Tons per sq. in.).
18·39

TRANSVERSE
Standard Bar.
(Breaking load tons).
1·87
(deflection ins.).
0·468

SPECIFIC WEIGHT.
(Water 1).
7·303

Specifications which have given these results and other information will gladly be furnished upon application.

For superiority, regularity and greater durability in your Special and difficult Castings try

FRODAIR IRONS

They have invariably yielded the best results during 25 years in specifications for, amongst other castings, the following:—

Cylinders of all kinds, Rolls (chilled and grain) Valves, Liners, Piston Rings, Stone Crushing Machinery, Hydraulic Plant, High Pressure Castings, Fire and Acid Resisting Castings, &c., &c.

WRITE NOW:— **The Frodair Iron & Steel Co., Ltd.,**

FENCHURCH HOUSE, LONDON, E.C. Telegrams: "Frodair, London."

COMPLETE SAND BLAST APPARATUS

For Cleaning large and small Castings.

WILL SAVE 50 PER CENT. IN FETTLERS' WAGES.

IN USE BY THE FOLLOWING WELL-KNOWN FIRMS:—

STEEL CASTINGS.

Beardmore, W., and Co., Ltd.	Glasgow.
Steel Co. of Scotland	Glasgow.
Coltness Iron Co.	Coltness.
Dickson and Manns, Ltd.	Armadale.
Vickers, Sons and Maxim, Ltd.	Barrow.
Darlington Forge Co., Ltd.	Darlington.
Shaw, W., and Co.	Middlesbrough.
Hadfields' Steel Foundry Co., Ltd.	Sheffield.
Osborn, S., and Co., Ltd.	Sheffield.
Jackson, P. R., and Co., Ltd.	Manchester.

MALLEABLE IRON.

Ley's Malleable Castings Co., Ltd.	Derby.
Crowley, John, and Co., Ltd.	Sheffield.
Baker Foundry Co., Ltd.	Smethwick.
Maddocks, J., and Co., Ltd.	Oakengates.
Clegg and Howgate, Ltd.	Keighley.
Croft Foundry Co., Ltd.	Walsall.
Lindop, H. W.	Walsall.
Tangyes Ltd.	Birmingham.
Harper, J., and Co.	Willenhall.
Haden, G. N., and Sons	Trowbridge.

ORDINARY IRON CASTINGS.

Platt Bros. and Co., Ltd.	Oldham.
Tweedales and Smalley	Castleton.
H.M. Dockyards	
Dobson and Barlow, Ltd.	Bolton.
Doulton and Co., Ltd.	Paisley.
Ruston, Proctor and Co., Ltd.	Lincoln.
Marshall, Sons and Co., Ltd.	Gainsborough.
Shanks and Co., Ltd.	Barrhead.
Falkirk Iron Co.	Falkirk.
Hopkinson and Co.	Huddersfield.

BRASS OR GUN METAL.

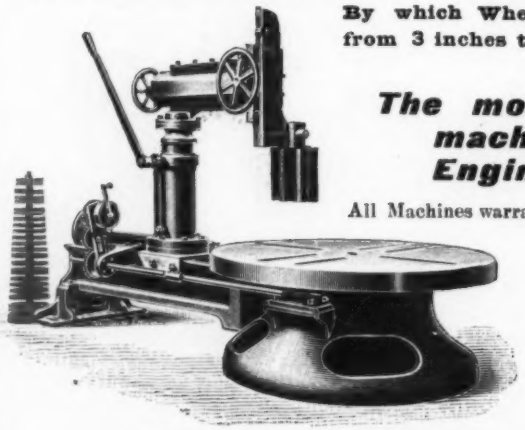
Vickers, Sons and Maxim, Ltd.	Barrow.
Gummer and Co.	Rotherham.
Ruston, Proctor and Co., Ltd.	Lincoln.
Storey, Isaac and Sons, Ltd.	Manchester.
Glenfield and Kennedy	Kilmarnock.
Milne, J., and Son	Edinburgh.
Benton and Stone	Birmingham.
British Insulated and Helsby Cables, Ltd.	
Marshall, Sons and Co., Ltd.	Gainsborough.
Dewrance and Co.	London.

General Representative: CEO. HOPKINS 63, Quarrenden Street, King's Road, Fulham, London, S.W.

TILGHMAN'S PATENT SAND BLAST Co., Ltd.,

BROADHEATH, Nr. MANCHESTER.

WHITTAKER'S IMPROVED MOULDING MACHINE



By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made.

The most complete and efficient machine hitherto introduced to Engineers.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

WM. WHITTAKER & SONS, LTD.,

SUN IRON WORKS, ***OLDHAM.***

Index to Advertisers.

Addresses, Telegraphic Addresses, and Telephone Numbers.

PAGE NO.	NAME.	ADDRESS.	TELEGRAPHIC ADDRESS.	TELEPHONE NO.
	Alldays & Onions, Ltd....	Birmingham	Alldays, Birmingham	328 Victoria
308	Bradley, T. & I., & Sons, Ltd.	Darlaston	Bradley, Darlaston	—
306	Britannia Foundry Co.	Coventry	Stoves, Coventry	251
C. iii.	Buffalo Forge Co.	Caxton House, London	Buffaloes, London	Victoria 420.
362	Cumming, William, & Co., Ltd.	Maryhill, Glasgow	Prudence, Glasgow	P.O. M. 25
C. ii.	Dempster, R. & J., Ltd.	Oldham Road, Manchester	Scrubber, Manchester	—
303	Davies, T., & Sons	West Gorton, Manchester...	Tuyere, Manchester	70 Openshaw
359	Durrans, Jas., & Sons	Penistone, nr. Sheffield	Durrans, Penistone	—
C. ii.	Dyson, J. & J.	Sheffield	Dyson's, Stannington...	702 Sheffield
357	Elders' Collieries Ltd.	Cardiff	Elder, Maesteg	10
355,312	Evans, J., & Co.	Manchester	Ladles, Manchester	2297
306	Everitt & Co.	40, Chapel Street, Liverpool	Persistent, Liverpool	1134 Central (3 lines)
363	Frodair Iron & Steel Co., Ltd.	5, Fenchurch Street, E.C.	Frodair, London	—
304	Fyfe, J. R. & Co.	—	—	—
	Goldendale Iron Co., Ltd.	Tunstall, Stoke-on-Trent	Goldendale, Tunstall, Staffs ...	—
304	Gould, George	Old Canal Wharf, Stourbridge... ...	—	—
310	Hall, Charles & Co.	Dantsic Street, Manchester	—	5814 City
308	Harris & Pearson...	Stourbridge	Fireclay, Stourbridge	7 Brierley Hill
306	Hislop, R. & G.	Paisley	Gas, Paisley	331 Paisley
304	Hodges & Co.	—	—	—
C. iv.	Jackman, J. W., & Co.	Caxton House, S.W.	Molders, London	30 Victoria
	Jenkins, W. J. & Co., Ltd.	Retford	Jenkins, Retford	—
358	Jones & Attwood, Ltd.	Stourbridge	Heat, Stourbridge	10, Stourbridge
355	Keith, James, & Blackman, Co., Ltd....	27, Farringdon Avenue, London ...	James Keith, London	6194 H'lb'rn(4 lines
308	King, Bros. (Stourbridge), Ltd.	Stourbridge	King Bros., Stourbridge	—
300	London Emery Works Co., Ltd.	Park, Tottenham	Naxium, London	99 Tottenham
354	Lowood, J. Grayson, & Co., Ltd.	Deepcar, nr. Sheffield	Lowood, nr. Sheffield	18 Stocksbridge
307	Macdonald, J. & Son, Ltd.	Maryhill, Glasgow	Compressor, Glasgow	161 Mary Hill
310	Marshall, H. P., & Co.	Leeds	Speciality, Leeds	909 Leeds
305	Metalline Cement Co.	112, Bath Street, Glasgow...	Adhesive, Glasgow	201 Y2 Douglas
305	Mitchell's Emery Wheel Co.	Bradford, Manchester	Diameter, Manchester	Central, 3375
304	McNeil, Chas.	Kinning Park, Glasgow	McNeil, Glasgow	X 155
302	Olsen, William	Cogan Street, Hull	Wm. Olsen, Hull	599 Y.I.
	PhillipsChas. D.	Newport, Monmouthshire	Machinery, Newport	18 & P.O. 576
308	Phillips J. W. & C. J.	23, College Hill, E.C.	Colloquial, London	10112 Central.
C. iii.	Plasti-Kion Co., The	Caxton House, S.W.	—	—
356	Portway, C. & Son	Halstead, Essex	Portway, Halstead, Essex	10 P.O. Halstead
308	Silent Machine Co.	Albion Works, Sallie St., Sheffield.	Forward, Sheffield	—
309	Samuelson & Co., Ltd.	Banbury	Samuelson, Banbury	—
301	Standard Sand Co., Ltd.	Mansfield	Standard Sand Co., Mansfield...	201 Mansfield
307	Stewart, D., & Co. (1902) Ltd.	London Road Ironworks, Glasgow...	Stewart, Glasgow	271 P.O.Bridgt'nd 3243Bridgton(N.
302	Sykes, James	Ashton-under-Lyne.	—	—
357	Thermit, Ltd.	27, Martin's Lane, E.C.	Fulmen, London	3749 Central
304	Tilghman's Patent Sand Blast Co., Ltd. ...	Broadheath, nr. Manchester	Tilghmans, Altrincham	14
311	Thwaites Bros., Ltd.	Bradford	Thwaites, Bradford	325 Bradford
	Vaughan & Sons, Ltd.	West Gorton, Manchester	Vaunting, Manchester	5113 Central
308	Walker, L. & I.	Rotherham	—	—
364	Whittaker, W., & Sons, Ltd.	Oldham	Whittakers, Engineers, Oldham	83
305	Wilkinson, Thos., & Co., Ltd.	Middlesbrough	Blacking. Middlesbro.	419
302	Williams, J. (B'ham Sand) Ltd.	Birmingham	—	—

MANSFIELD MOULDING SAND.

As Shipped by us to all parts of the World,
for Castings of Iron, Brass, Aluminium, &c.

WRITE STATING CLASS OF WORK TO

The Standard Sand Co., Ltd.,
Mansfield, NOTTS.

"THE RIGHT ARTICLE AT THE RIGHT PRICE."

PLUMBAGO,

BLACKING, :-: TERRA FLAKE,
PARTING POWDER, CRUCIBLES,

CORE GUM, &c.

AND ALL EQUIPMENT FOR THE FOUNDRY.

WRITE FOR NEW CATALOGUE

WM. OLSEN, COGAN STREET, —HULL.—

FOUNDRY SANDS

OF ALL GRADES.

Owners of noted Birmingham Moulding Sand Quarries—

JOHN WILLIAMS (BIRMINGHAM SAND) LTD.
BIRMINGHAM.

Ironfounders' Charcoal Blacking, Mineral Blacking, Coal & Coke Dust Manufacturer,

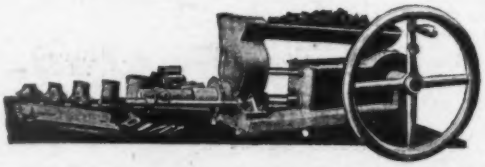
&c.

JAMES SYKES, HURST CHARCOAL MILL, Near ASHTON-UNDER-LYNE.

ESTABLISHED 1554.

THE SWEDISH PATENT

"PERFECT" CORE MACHINE



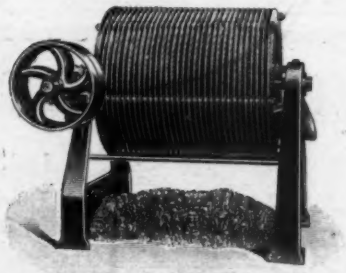
supersedes all the machines with screws, which wear out. It works with a plunger, and is built to last. No oil or binder is required. Some hundreds giving satisfaction in Sweden, Norway, England, Germany, Russia, &c.

THE LATEST & BEST

SAND SIFTER & MIXER

OUTPUT 2 TONS PER HOUR.

MAYER-PHILLIPS PATENT. 1911.



This machine is replacing other types owing to its simple, strong and practical design. Constant supply of sand, no attention, little power. All kinds of sand can be treated.

J. W. & C. J. PHILLIPS, LTD., 23, College Hill, Cannon Street, **LONDON, E.C.**

T. DAVIES & SON,

RAILWAY WORKS, WEST GORTON, MANCHESTER.

ON ADMIRALTY LIST.

Telegrams—"TUYERE, MANCHESTER. Nat. Telephone—No. 70, OPENSHAW.

Specialities

FOUNDRY CUPOLAS & LADLES

ALL TYPES AND SIZES IN STOCK OR PROGRESS.

LICENSEES and MAKERS of

Osborn's Patent Spark Arrester

FOR FOUNDRY CUPOLAS.

Efficient. Simple in Design.

Require no Attention.

Prevent Fire or Damage to Surrounding Buildings.

SAVE THE COST OF FREQUENT CLEANING OF THE ROOFS AND GUTTERS.

THOROUGHLY RELIABLE.

HODGES PATENT TURBINE BLOWERS.

40% Less Power to Drive than any other Blower.

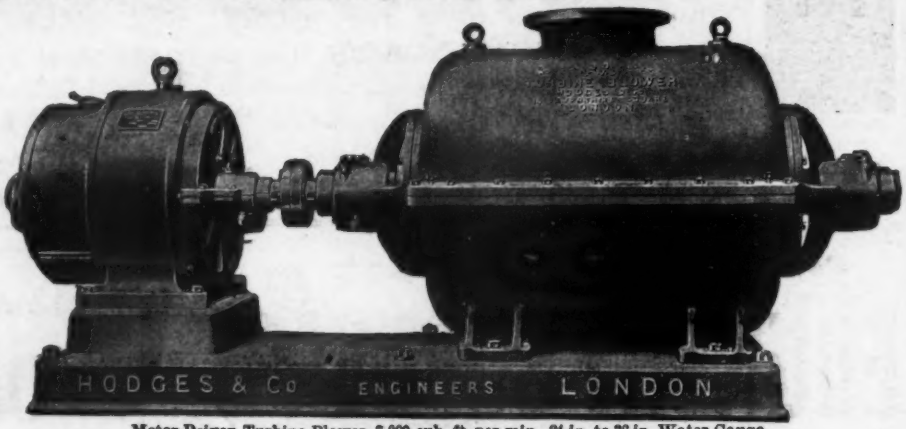
NO INTERNAL FRICTION.

NO NOISE.

NO WEAR AND TEAR.

PERFECTLY STEADY. BLAST PRESSURE

Direct—Coupled to Electro-Motor, Steam Turbine, Petrol Engine or with Pulley for Belt Driving.



Motor-Driven Turbine Blower, 8,000 cub. ft. per min., 24 in. to 36 in. Water Gauge. Melting Capacity 12 to 16 tons per hour.

Made in 8 Standard Sizes, Capacities 50 to 15,000 Cubic feet per min.

VARYING PRESSURES UP TO **20 lbs.** PER SQUARE INCH.

For BLAST FURNACES, STEEL CONVERTERS, CUPOLAS, SMITH'S HEARTHS and OTHER PURPOSES

HIGHEST CLASS BRITISH MATERIAL AND WORKMANSHIP.

***R. J. HODGES & CO.,* ENGINEERS, 14, DEVONSHIRE SQUARE, BISHOPSGATE, LONDON, E C**

38½"
McNEIL'S PATENT UNBREAKABLE STEEL LADLES.
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical or metallurgical processes. List of sections and prices on application to
CHAS. McNEIL.
KINNING PARK IRONWORKS, GLASGOW.
36"
32½"

Can also be made in Aluminium.

CUPOLA BRICKS

FOR LINING ORDINARY AND PATENT

CUPOLA FURNACES.

JOHN R. FYFE & Co.,

SHIPLEY, Yorks.

GEORGE GOULD,

OLD CANAL WHARF, STOURBRIDGE.

FOUNDRY SAND

(MINE OWNER).

IRON AND COAL MERCHANT.

PROMPT DELIVERIES BY TRUCK OR BOAT.

SCRAP HEAP REDUCED TO A MINIMUM.

REGISTERED

TRADE MARK.

METALLINE CEMENT COMPOUNDS.

INDISPENSABLE IN THE FOUNDRIES AND ENGINEERING WORKSHOPS NOW RECOGNISED TO BE THE **MOST RELIABLE IRON COMPOUNDS** THAT CAN BE PROCURED.

VALUABLE for treating defective Castings, making permanent repairs to Engines, Boilers, Tanks, etc., etc.

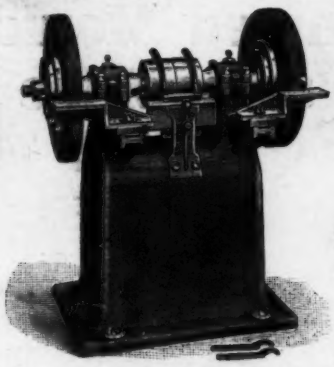
WRITE FOR **FREE** TRIAL **SAMPLES, PRICE LIST** AND **INSTRUCTION BOOK.**

THE METALLINE CEMENT CO., Sole proprietors and manufacturers: (HEAD OFFICE): 112, BATH STREET, **GLASGOW.**

HIGH-CLASS

GRINDING WHEELS

FOR ALL WORK.



UP-TO-DATE

GRINDING MACHINES

OF ALL TYPES.

MITCHELL'S EMERY WHEEL CO.,

Castle Works, Bradford, MANCHESTER.

: : SEND FOR NEW ILLUSTRATED LIST. : :

TELEPHONE: 3575 CENTRAL. TELEGRAMS: DIAMETER, MANCHESTER.

It will Pay You to Use the Best

COAL DUST

None is quite so good as that made from Best Durham Coal. We grind and screen it into several different sizes to suit different kinds of work, and can put it on Rails or Ship it at Middlesbrough, Stockton or West Hartlepool at a very low price.

We actually send it to distant Coal producing districts where the carriage costs more than the Coal Dust. This demand proves its excellence! Why not try it?

THOMAS WILKINSON & Co., LTD., Foundry Stores, **MIDDLESBROUGH.**

FERRO-VANADIUM. * * * **FERRO-TITANIUM.**
SILICO-MANGANESE {23/30 % Silicon, 65/70 % Manganese & 1 %, 2 %, 3 %, Carbon Maximum.
FERRO-SILICON Containing 25 %, 50 %, 75 % Silicon.
FERRO-CHROME 65/70 % Cr. & 1 % up to 8/10 % Carbon Maximum.
ALUMINIUM 98/99 % Purity. *In Notched Bars and Half Round Sticks and Granular.*
WE SUPPLY ALL CLASSES OF MINERALS, METALS AND METALLIC ALLOYS.
EVERITT & CO., 40, CHAPEL ST., LIVERPOOL.
Telegrams: "PERSISTENT." Telephone No. 1194 (3 lines).

A Hand Rammed Moulding machine is only Half a machine . .

BUT EVEN THIS WILL DO THREE or four times as much work per diem as a hand moulder.

Our No. 3 Machine illustrated will draw a pattern 10 in. deep and can be adjusted in one minute to take any box from 6 in. to 30 in. square, oblong or round.

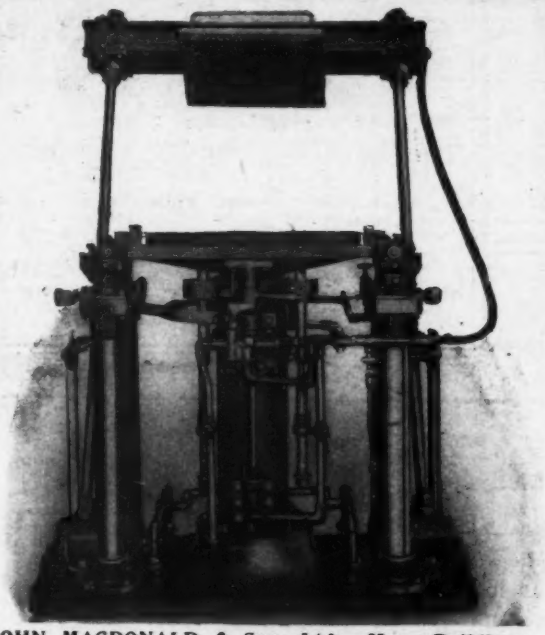
We are also makers of Power Rammed machines.

SEND FOR CATALOGUE TO

BRITANNIA FOUNDRY Co.,
COVENTRY, Eng.

EFFICIENT AND ECONOMICAL HEATING OF FOUNDRY STOVES,
. . . ANNEALING OVENS, FURNACES, &c. . . .

R. & G. HISLOP,
Gas Engineers, Underwood House, PAISLEY.



JOHN MACDONALD & Son, Ltd., Moor Buildings, Pilgrim Street, Newcastle-on-Tyne.
JOHN MACDONALD & Son, Ltd., Norwich Union Chambers, Birmingham.
JAMES R. KELLY & Co., Bridge End, Leeds Bridge, Leeds.

Telegrams:—"Compressor, Glasgow."
Telephones:—National, 61 Maryhill, Post Office, 69 Kelvin.

John Macdonald
—— & SON, Limited. ——

Pneumatic Engineers,

WATT ST., MARYHILL, GLASGOW

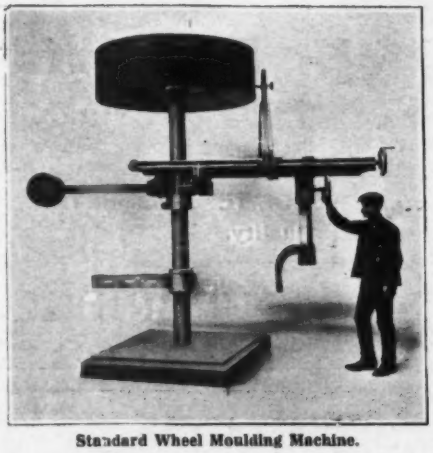
"Ajax" Pneumatic Combined Jolting and Power Press Moulding Machine.

The Machine that is suitable for deep and shallow work.

The Machine that will make a complete mould in a few seconds without any hand work, forms the sand hardest about the pattern.

Inquiries and Correspondence Invited.

British Made Pneumatic Appliances for the Foundry.



Standard Wheel Moulding Machine.

ALL IRON AND STEEL FOUNDRIES

SHOULD BE EQUIPPED WITH

STEWART WHEEL MOULDING MACHINES.

Complete Satisfaction Guaranteed

* *

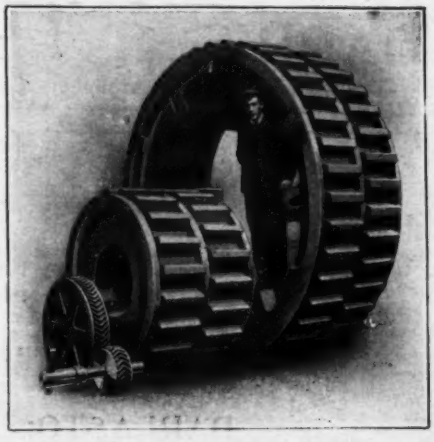
No Loose Parts Liable to be Lost.

ACCURATE. PORTABLE. CHEAP.

WRITE FOR PRICE AND PARTICULARS TO

DUNCAN STEWART & CO., LTD.

LONDON ROAD IRONWORKS, GLASGOW.



Wheels Moulded by this Machine.

FIRE BRICKS & CLAY

CUPOLA BRICKS.

BEST QUALITY.

LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.

KING BROTHERS,

(STOURBRIDGE) Ltd.,

STOURBRIDGE.

S.M.S

WHAT IS IT?

SWIFT — METALLIC — STOPPING

The British Foundry Cement.

FOR FILLING UP BLOW HOLES IN CASTINGS . . . . . IT DRIES IN ONE HOUR, AND IT CAN BE FILED UP IN FROM SIX TO TWELVE HOURS . . . .

SAMPLE FREE — TRIAL TIN 1/-

AGENTS WANTED.

THE SILENT MACHINE COMPANY,

SAVILE STREET, SHEFFIELD.

WE SUPPLY **THE** LEADING FIRMS IN THE TRADE WITH

FOUNDRY BLACKINGS

OF ALL KINDS,

COAL DUST, CHARCOAL, PLUMBAGO and BLACK-LEAD, CORE GUMS and all Foundry Requisites, and have done so since 1831.

I. & I. WALKER, *EFFINGHAM MILLS,* ***ROTHERHAM.***

Our Specialite is Studying Special Requirements.

KINDLY HAND US YOUR ENQUIRIES.

STOURBRIDGE FIRE BRICKS

Of Best Quality for Lining Cupolas In Stock,

ALSO MADE TO ANY DESIGN.

Linings Stocked to Customers' Plans to ensure IMMEDIATE DELIVERY.

All kinds of Fireclay Goods of Highest Quality.

HARRIS & PEARSON, STOURBRIDGE.

Telegrams:—"FIRECLAY, STOURBRIDGE." Telephone:—No. 7 Brierley Hill.

T. & I. BRADLEY & SONS, LTD.,

COLD BLAST PIG IRON

PIG IRON BRANDS

PART MINE. WARM AND COLD BLAST. I X L. ALL MINE. A M

TO GUARANTEED ANALYSIS.

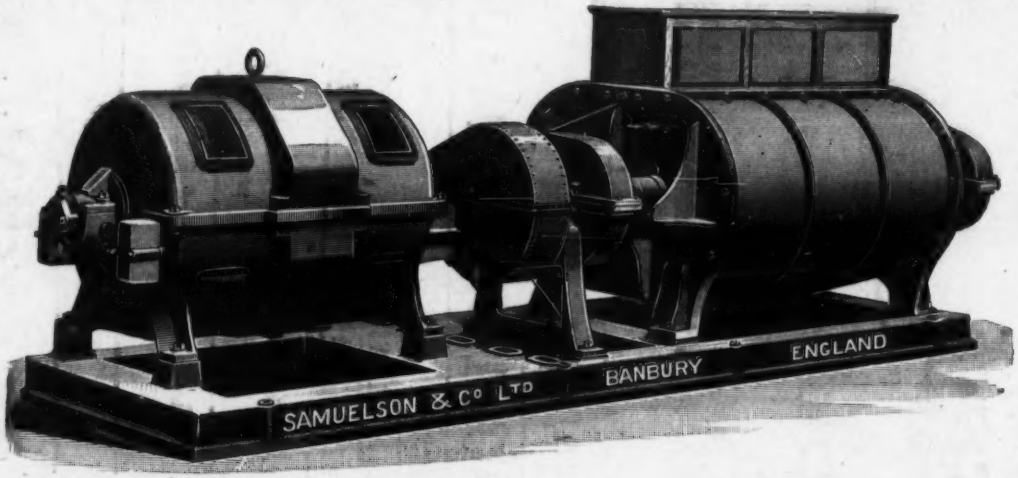
DARLASTON BLAST FURNACES,

DARLASTON, SOUTH STAFFS.

SAMUELSON & Co., LTD., BANBURY, ENGLAND,

CONTRACTORS TO THE ADMIRALTY, WAR OFFICE, COLONIAL and FOREIGN GOVERNMENTS.

For Ordinary or High Pressures up to 10 lbs. per square inch.



OVER 10,000 MADE AND SOLD.

MANUFACTURERS OF

ROOTS' "ACME" BLOWERS,

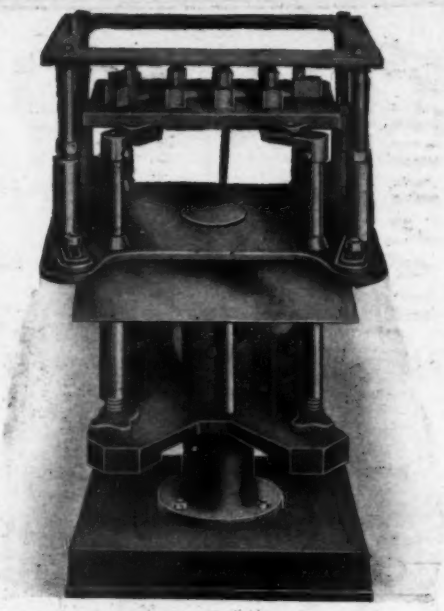
Driven by Electric Motor, Simple or Compound Steam Engine.

Also Makers of

SMITHS' HEARTHS, FOUNDRY MOULDING MACHINES, &c.

Full particulars sent on application. **See our Advertisement every alternate month.**

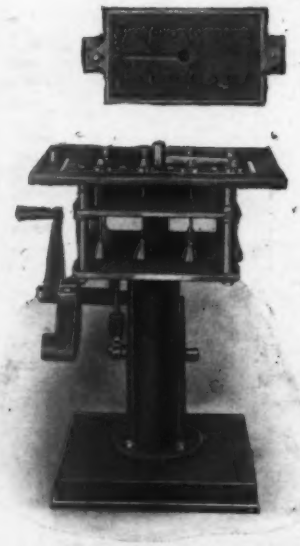
THE MACHINE YOU NEED IN YOUR FOUNDRY.



CLASS "B."
ADAPTABLE TO VARIOUS SIZES OF PATTERN PLATES.

THE "PHOENIX" MOULDING MACHINE.

THE BEST,
THE SIMPLEST,
THE CHEAPEST.



CLASS "A."

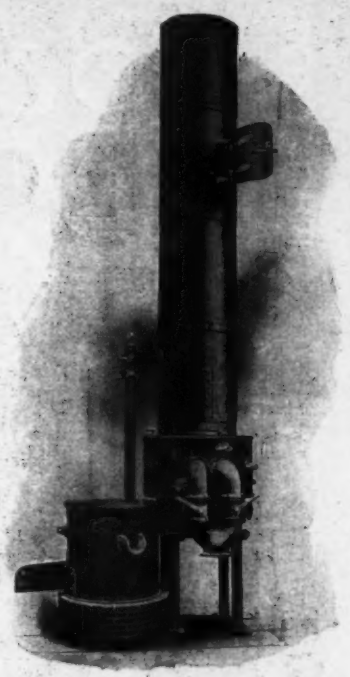
Reduces bench Moulding to an accurate Mechanical process.

It eliminates the cost of fettling and fitting inaccurate Castings.

Operated by unskilled labour.

CHAS. HALL & Co.,
Newtown Ironworks,
Dixon Street, Dantzic Street,
MANCHESTER.

FOUNDRY PLANT.



"Rapid" Cupolas

WITH OR WITHOUT RECEIVERS OR DROP BOTTOMS.

Roots' Blowers

FOR ENGINE, BELT, OR ELECTRIC DRIVING.

STEAM HAMMERS,
FORGE PLANT,
ROOT'S' BLOWERS,
"RAPID" CUPOLAS,
FOUNDRY PLANT,
CENTRIFUGAL PUMPS,
AND FANS.
HIGH SPEED ENGINES
WITH
FORCED LUBRICATION
A SPECIALITY.
THE "BRADFORD" PATENT
BOILER FEED PUMP.
CATALOGUES ON APPLICATION.

THWAITES BROS., Ltd.,

BRADFORD.

LADLES, HOISTS,
PLATFORMS,
JIB CRANES, Etc.

London Office—
96 & 98, Leadenhall Street, E.C.

COMPLETE
Foundry Equipment.
Telegrams: "LADLES" MANCHESTER
Telephone: "N° 2297 CENTRAL" MANCHESTER.
REDISTIK FILLET
"TAPIX"
CORE GUM
JAMES EVANS & Co. BRITANNIA WORKS,
BLACKFRIARS, MANCHESTER.